Merrimack Valley Flood Control

Definite Project Report

for

MOUNTAIN BROOK RESERVOIR

Mountain Brook, New Hampshire

Corps of Engineers, U.S. Army

U.S. Engineer Office

Boston, Mass.

ABSTRACT OF BIDS

Invitation for Bids No. 19-023-46-63
For Construction of Mountain Brook Dam, Jaffrey, New Hampshire

U. S. Engineer Office, Boston, Mass.
Opened 11:00 A.M., 5 April 1946

Item No.	Designation	Estimated Quantities	Unit	Bid 1 Unit Price	Bid 1 Total	Bid 2 Unit Price	Bid 2 Total	Bid 3 Unit Price	Bid 3 Total	Bid 4 Unit Price	Bid 4 Total	Government Estimate Unit Price	Government Estimate Total
BID NUMBER				1		2		3		4			
NAME AND ADDRESS OF BIDDER				Central Construction Company, Lawrence, 6 Beacon Avenue, Lawrence, Mass.		Carlo Bianchi & Company, Inc., 24 Union Avenue, Framingham, Mass.		B. Perini & Sons Inc., 73 Montwait Avenue, Framingham, Mass.		Callen Construction Corporation, 539 Hope Street, Bristol, Rhode Island		Government Estimate	
1.	Temporary Roads	1	Job	-	$ 7,000.00	-	$ 7,050.00	-	$ 20,000.00	-	$ 30,000.00	-	$ 11,425.00
2.	Removal of Existing Structures	1	Job	-	2,200.00	-	4,000.00	-	6,500.00	-	14,000.00	-	3,320.00
3.	Clearing	1	Job	-	3,000.00	-	8,500.00	-	7,700.00	-	20,500.00	-	3,250.00
4.	Diversion and Care of Brook	1	Job	-	15,000.00	-	30,000.00	-	27,000.00	-	60,441.50	-	10,360.00
5.	Stripping	46,000	Cu.Yd.	.30	13,800.00	.40	18,400.00	.80	36,800.00	.70	32,200.00	.45	20,700.00
6.	Common Excavation	86,000	Cu.Yd.	.33	28,380.00	.70	60,200.00	.77	66,220.00	.75	64,500.00	.50	43,000.00
7.	Excavation & Haul, Borrow Area A	127,000	Cu.Yd.	.30	38,100.00	.40	50,800.00	.55	69,850.00	.85	107,950.00	.45	57,150.00
8.	Excavation & Haul, Borrow Area B	27,000	Cu.Yd.	.60	16,200.00	.60	16,200.00	.70	18,900.00	1.10	29,700.00	.60	16,200.00
9.	Rock Excavation	1,000	Cu.Yd.	5.00	5,000.00	3.00	3,000.00	3.25	3,250.00	9.00	9,000.00	2.25	2,250.00
10.	Road Scarification	1,400	Sq.Yd.	.10	140.00	.25	350.00	.30	420.00	.25	350.00	.33	462.00
11.	Grout Pipes	13	Each	2.00	26.00	15.00	195.00	16.25	211.25	12.00	156.00	20.00	260.00
12.	Drilling Holes for Pressure Grouting	260	Lin.Ft.	1.00	260.00	2.00	520.00	1.35	351.00	2.00	520.00	3.00	780.00
13.	Pressure Grouting	100	Cu.Ft.	10.00	1,000.00	3.00	300.00	2.25	225.00	3.00	300.00	8.80	880.00
14.	Sand and Gravel	9,500	Cu.Yd.	1.00	9,500.00	1.00	9,500.00	1.30	12,350.00	2.00	19,000.00	.71	6,745.00
15.	Screened Gravel	500	Cu.Yd.	6.00	3,000.00	5.00	2,500.00	6.00	3,000.00	5.00	2,500.00	4.90	2,450.00
16.	Compacted Fill	175,000	Cu.Yd.	.15	26,250.00	.15	26,250.00	.35	61,250.00	.30	52,500.00	.15	26,250.00
17.	Tamped Fill	6,000	Cu.Yd.	.40	2,400.00	.50	3,000.00	1.35	8,100.00	1.00	6,000.00	.82	4,920.00
18.	Additional Rolling	1,500	100 Sq.Ft.	.40	600.00	.20	300.00	.08	120.00	.10	150.00	.21	315.00
19.	Riprap	8,300	Cu.Yd.	8.30	68,890.00	4.00	33,200.00	7.00	58,100.00	8.00	66,400.00	3.00	24,900.00
20.	Top Soiling and Seeding 4-inches Deep	140	1000 Sq.Ft.	18.00	2,520.00	30.00	4,200.00	29.00	4,060.00	65.00	9,100.00	35.75	5,005.00
21.	Top Soiling and Seeding 9-inches Deep	125	1000 Sq.Ft.	40.00	5,000.00	50.00	6,250.00	50.00	6,250.00	100.00	12,500.00	46.95	5,868.75
22.	Concrete in walls	3,000	Cu.Yd.	24.00	72,000.00	18.50	55,500.00	25.00	75,000.00	22.00	66,000.00	16.55	49,650.00
23.	Concrete in spillway floors	2,650	Cu.Yd.	12.00	31,800.00	11.00	29,150.00	13.00	34,450.00	20.00	53,000.00	12.85	34,052.50
24.	Concrete in conduit	260	Cu.Yd.	30.00	7,800.00	16.50	4,290.00	50.00	13,000.00	35.00	9,100.00	31.60	8,216.00
25.	Concrete in Bridge	575	Cu.Yd.	30.00	17,250.00	18.50	10,637.50	25.00	14,375.00	25.00	14,375.00	21.50	12,362.50
26.	Furnishing Cement	9,800	Bbls.	2.90	28,420.00	3.70	36,260.00	4.00	39,200.00	3.20	31,360.00	3.70	36,260.00
27.	Steel Reinforcement	515,000	Lb.	.08	41,200.00	.07	36,050.00	.07	36,050.00	.08	41,200.00	.08	41,200.00
28.	Copper Water Stops	250	Lb.	1.25	312.50	1.10	275.00	.90	225.00	1.00	250.00	1.65	412.50
29.	Miscellaneous Metal	1	Job	-	500.00	-	700.00	-	650.00	-	800.00	-	550.90
30.	Vertical Joint Protection	675	Lin.Ft.	1.00	675.00	1.00	675.00	2.30	1,552.50	1.00	675.00	1.20	810.00
31.	Cement-Asbestos Pipe for Weep Holes	175	Lin.Ft.	1.00	175.00	1.10	192.50	.70	122.50	2.00	350.00	1.80	315.00
32.	Spillway Subdrain	1	Job	-	3,000.00	-	2,800.00	-	3,500.00	-	3,000.00	-	2,000.00
33.	Walks and Steps	1	Job	-	1,000.00	-	300.00	-	250.00	-	500.00	-	570.00
34.	Drainage System	1	Job	-	1,100.00	-	1,350.00	-	1,500.00	-	800.00	-	950.00
35.	Sand and Gravel Road Courses	2,000	Cu.Yd.	1.00	2,000.00	1.50	3,000.00	1.60	3,200.00	1.50	3,000.00	1.39	2,780.00
36.	Bituminous Surface Treatment	4,000	Gal.	.20	800.00	.20	800.00	.17	680.00	.16	640.00	.20	800.00
37.	Cover Aggregate	47	Ton	3.00	141.00	5.00	235.00	4.00	188.00	3.00	141.00	4.55	213.85
38.	Road Mix Pavement	875	Ton	4.00	3,500.00	5.00	4,375.00	6.00	5,250.00	6.00	5,250.00	3.60	3,150.00
39.	Cut-Back Asphalt for Road-Mix Pavement	9,900	Gal.	.15	1,485.00	.20	1,980.00	.16	1,584.00	.16	1,584.00	.19	1,881.00
40.	Plant Mix Pavement for Bridge	30	Ton	15.00	450.00	20.00	600.00	14.00	420.00	15.00	450.00	11.00	330.00
41.	Granite Curb	1	Job	-	1,100.00	-	1,050.00	-	1,300.00	-	400.00	-	875.00
42.	Bridge, Spillway and Outlet Works Guard Rails	1	Job	-	7,000.00	-	7,000.00	-	8,700.00	-	8,000.00	-	10,125.00
43.	Highway Guard Rail	2,400	Lin.Ft.	2.20	5,280.00	2.00	4,800.00	2.15	5,160.00	2.00	4,800.00	2.10	5,040.00
44.	Wheel Stop	14	Each	35.00	490.00	20.00	280.00	20.00	280.00	50.00	700.00	25.00	350.00
45.	Gage House	1	Job	-	1,000.00	-	1,350.00	-	1,150.00	-	2,000.00	-	890.00
46.	Stop Logs	1	Job	-	400.00	-	200.00	-	300.00	-	200.00	-	140.00
47.	Steel Sheet Piling	3,150	S.F.	3.00	9,450.00	2.00	6,300.00	1.75	5,512.50	3.50	11,025.00	2.20	6,930.00
48.	Log Boom	1	Job	-	2,500.00	-	2,300.00	-	3,300.00	-	2,500.00	-	2,800.00
	TOTAL BID PRICE				$489,094.50		$497,165.00		$567,556.75		$799,867.50		$470,145.00
	SURETY AND AMOUNT			American Employers' Insurance Co.	$120,000.00	Maryland Casualty Company	20 Percent of Bid	Maryland Casualty Company	20 Percent of Bid	Aetna Casualty & Surety Company	$160,000.00		

REMARKS:

Bidder No. 1: List of Available Plant to be Used not furnished.
Statement of contractor's experience not furnished.

Bidder No. 2: List of Available Plant to be Used not furnished.
Statement of contractor's experience not furnished.

Bidder No. 3: List of Available Plant to be Used not furnished.
Statement of contractor's experience not furnished.
Reference to Addendum No. 1 not inserted in bid form.

APPROPRIATION: 21X3113 Flood Control, General, First Deficiency Appropriation Act 1946, Approved 28 December 1945. (Mountain Brook Reservoir, Merrimack River Basin, New Hampshire).

DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

MERRIMACK RIVER BASIN FLOOD CONTROL

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WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
3D FLOOR, PARK SQUARE BLDG.
31 ST. JAMES AVENUE
BOSTON, MASS.

June 1, 1940
(Revised - December 16, 1940)

Subject: Definite Project Report for Mountain Brook Reservoir - Merrimack River Basin Flood Control

To: The Chief of Engineers, U.S.Army, Through the Division Engineer, North Atlantic Division, New York, N.Y.

1. Project Authority.- Mountain Brook Reservoir is proposed as an element of the comprehensive plan for flood control reservoirs and related flood control works for the Merrimack River Basin authorized by the Flood Control Acts approved June 22, 1936, and June 28, 1938. The Flood Control Act approved June 28, 1938, provides that, "The project for flood control in the Merrimack River Basin, as authorized by the Flood Control Act approved June 22, 1936, is modified to provide, in addition to the construction of a system of flood control reservoirs, related flood control works which may be found justified by the Chief of Engineers."

2. Previous Investigations.- The investigations and studies upon which the authorized project for the Merrimack River Basin is based are described in House Document 689, 75th Congress, 3d Session. A comprehensive plan of flood control reservoirs and related flood control works, at an estimated total cost of $21,000,000, was recommended in that document and authorized by the Flood Control Act approved June 28, 1938. Definite project reports have been approved for three flood control reservoirs under the general Merrimack Basin authorization, as follows:

Reservoir	Estimated Cost*	Status
Franklin Falls	$ 7,883,000	Construction started, Oct. 1938.
Blackwater	$ 1,300,000	Construction started, Jan. 1940.
Hopkinton-Everett	$11,300,000	Final plans and specifications being prepared.

*The cost figures shown are inclusive of $575,000 required for penstocks and related power facilities which were not included in the original project estimates upon which the existing authorization is based.

Preliminary definite project reports on Mountain Brook Reservoir and West Peterboro Reservoir were submitted April 25, 1940, as part of the comprehensive plan. The preliminary reports were approved by the Chief of Engineers on April 30, 1940. The two reservoirs proposed at that time are:

Reservoir	Drainage Area (sq.mi.)	Flood Control Storage (acre-feet)	Estimated Cost
West Peterboro	44	16,000	$1,170,000
Mountain Brook	14	4,800	$ 370,000

3. Location and Description.- The proposed Mountain Brook Reservoir is located within the town of Jaffrey, Cheshire County, New Hampshire, on Mountain Brook immediately above its confluence with the Contoocook River. (See Plates 1 and 2.) The project involves the construction of an earth dam and appurtenant works about a mile above the village of East Jaffrey, adjacent to and including U.S. Highway No. 202 as it crosses Mountain Brook. The reservoir, which will control a drainage area of 14 square miles, has an area at spillway lip (El. 1026) of 370 acres and a flood control storage capacity of 4800 acre-feet, which is equivalent to 6.4 inches of run-off.

4. The land to be acquired for the reservoir area is principally undeveloped and swampy. The side slopes of the drainage basin contiguous to the reservoir area are moderately steep, becoming steeper in the remote regions, the extreme westerly section rising on the eastern slope of Mt. Monadnock. The proposed reservoir will affect four short sections of highway. Two of these sections will be raised, and a third, crossing at about the center of the area, will be abandoned during the periods of flooding in the reservoir area. The fourth section, located at the dam site, will be incorporated in the dam and will be carried over the spillway by means of a bridge. There are no railroad lines involved in the reservoir area as proposed herein. Operation of the proposed Mountain Brook Reservoir during moderate and extreme flood conditions will change tailwater conditions below the adjacent Contoocook Lake Dam. Only minor spillway and embankment modifications will be necessary at this low dam to offset the new conditions and these will be provided as part of this project. The project is designed for the control of floods in the upper Contoocook River Basin and will not interfere with the normal flow of the stream.

5. Description of Structures.- The proposed dam will consist of a rolled earth embankment about 1000 feet long between two glacial till abutments, with top elevation 1042 and a maximum height of about 45 feet. (See Plates 3 and 4.) The outlet works consist of a single

uncontrolled reinforced concrete conduit, 16 square feet in area, placed in a cut through the undisturbed glacial till overburden of the left abutment and discharging into a stilling basin. The spillway, located in an overburden cut through the left abutment, will be concrete-lined, with a crest elevation of 1026 and crest length of 100 feet at the control section. The upstream portion of both the dam and dike embankments will consist of impervious material and the remainder of pervious material. The design of the embankment section is tentative, depending on relative quantities of impervious and pervious materials available from borrow areas. In addition, there will be a dike embankment across a saddle adjoining the right abutment 700 feet long and 30 feet high at its maximum section. A more complete description of the considerations involved in the selection of these structures is contained in Appendixes C and D.

6. Hydrology and Hydraulics.- The spillway, operating under the maximum design surcharge of about 13 feet, will pass a flow of 15,800 c.f.s., which is the outflow derived from routing the spillway design flood through the reservoir. The peak inflow of this flood is 29,500 c.f.s., which is equivalent to a run-off of 2,110 c.f.s. per square mile over the 14-square-mile tributary drainage area. An index of the magnitude of this flood is given by the value of 7900 for the coefficient "C" in the formula $Q = C\sqrt{A}$. The reservoir will be a simple retarding basin with a single ungated outlet, 16 square feet in cross-sectional area, having a maximum discharge capacity of 360 c.f.s. with the reservoir filled to the spillway lip (Elev. 1026). The capacity of the reservoir to spillway crest and the capacity of the outlet have been selected to provide control of a reservoir design flood derived from a study of the March 1936 and September 1938 floods, the largest floods of record in this area. The outlet will discharge through a stilling basin into the Contoocook River at a location remote from the embankment. A more complete description of the factors involved in the hydrologic and hydraulic considerations of Mountain Brook Reservoir is contained in Appendixes A and B.

7. Estimated Cost.- A detailed estimate of cost is given in Appendix E. A summary of the estimated cost is given herewith:

Dam, spillway, and outlets	$ 290,000
Lands and rights-of-way	40,000
Relocation	40,000
Total Estimated Cost	$ 370,000

8. Economic Analysis.- The proposed Mountain Brook Reservoir has been found to be the most economical measure of local protection for the towns of East Jaffrey and Peterboro in the upper reaches of the Contoocook River. The cost of dikes and walls for the protection

of these towns would be excessive. The use of a small reservoir for the protection of the upper reaches of the Contoocook has the further advantage of contributing to the effectiveness of the large reservoirs which comprise the main system for protection of the principal downstream damage centers. The operation of Mountain Brook Reservoir in conjunction with other proposed reservoirs in the Contoocook Basin will provide a high degree of protection for the Contoocook Basin, the need for which was presented at hearings recently held by the New Hampshire Water Resources Board. The site has no practical value for multiple-purpose development because of the small drainage area. This conclusion has been concurred in by representatives of the Federal Power Commission at informal conferences in the Boston Office. The economic analysis is shown in the following tabulation for Mountain Brook operating alone and in conjunction with other reservoirs under construction or proposed for construction under the comprehensive plan.

Item	Mountain Brook Reservoir	Other Reservoirs Proposed for Comprehensive Plan*	Total All Reservoirs
Net Drainage Area (sq.mi.)	14	1,603.5	1,617.5
Flood Control Storage - (acre-feet)	4,800	392,000	396,800
(inches)	6.4	4.6	4.6
Estimated Cost	$370,000	$21,653,000	$22,023,000
Annual Carrying Charges	$ 16,000	$ 1,003,900	$ 1,019,900
Annual Benefits	$ 21,000	$ 1,122,000	$ 1,143,000
Ratio of Benefits to Costs	1.31	1.10	1.12
Cost Per Acre-Foot of Storage	$77	$55	$56
% of Merrimack Basin Annual Damages Prevented	1	73	74

*Namely Franklin Falls, Blackwater, Hopkinton-Everett, and West Peterboro (see paragraph 2).

9. Local Cooperation.- Since Mountain Brook Reservoir is proposed for construction as an element of the comprehensive plan for the Merrimack River Basin as authorized by the Flood Control Act approved June 28, 1938, no local financial contribution is required. Under an existing statute of the State of New Hampshire, consent of the State must be obtained for the proposed work. A request for consent to the proposed construction has been made, the procedure having been approved by Departmental wire dated May 18, 1940 (File 3F).

10. Time Required for Construction.- It is estimated that the proposed work can be completed in a construction period of seven months.

11. Recommendation.- It is recommended that Mountain Brook Reservoir be selected as a definite project for construction under the authorized comprehensive plan for the Merrimack River Basin and that preparation of plans and specifications be started immediately upon receipt of consent of the State of New Hampshire for acquisition of lands. Sufficient funds for final design, plans and specifications have been included in the tentatively approved allotments for "Merrimack Basin, Surveys and Designs" for fiscal year 1941.

DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

APPENDIX A

HYDROLOGY

1. Reference.- Reference is made to Engineer Bulletin R.& H. No. 9, 1938, subject, "Spillway Capacities," which directs, in paragraph 19, that a hydrology report will be submitted to the office of the Chief of Engineers for approval as the first step in the final design of a project.

2. Project Description.- The Mountain Brook Reservoir will be formed by a proposed dam near the mouth of Mountain Brook, with a tributary drainage area of 14 square miles. The reservoir is located about a mile upstream from East Jaffrey and is intended to provide flood protection for the upper Contoocook River Basin, principally to the town of East Jaffrey, N.H., and, to a lesser extent, the town of Peterboro, N.H. (see Plate 2). The reservoir will act as a simple retarding basin having a single ungated outlet capable of discharging about 360 c.f.s. at full pool. The total storage capacity to spillway lip elevation (1026) is 4800 acre-feet (see Plate 12). A maximum of 300 acre-feet of storage is required to develop sufficient head to pass ordinary flows, leaving a net flood control storage of at least 4500 acre-feet, equivalent to 6.0 inches of run-off over the drainage area. The spillway is in a cut through the left abutment, with a 100-foot concrete control section at Elev. 1026. The spillway discharge passes into a converging concrete flume and through a stilling basin into the Contoocook River.

3. Basin Characteristics.- The drainage area of 14 square miles has a maximum width of about 3-1/2 miles and a maximum length of 6 miles along the general direction of flow. Mountain Brook is a three-branch stream. The two larger branches rise on the steep slopes of Mt. Monadnock and their physical characteristics indicate that flood peak flows from these two tributaries arrive at their confluence at practically the same time. The slopes of Mt. Monadnock, with maximum elevation of 3165 feet, drop nearly 2000 feet in the upper third of the basin length, hence produce headwater inflows of extremely high intensity. In the lower two-thirds of the basin length the stream channels have a fall of about 200 feet, with considerable swampy area along each of the three branches.

4. Stream Flow Data.- There are no recorded data on the flood discharges of Mountain Brook. The best available data are the computed peak discharges for the 1936 and 1938 floods on the Contoocook River near East Jaffrey for a drainage area of 36.1 square miles. Peak values determined by the U.S. Geological Survey for the 1936

flood and for the 1938 flood are 2580 c.f.s. and 3560 c.f.s., respectively. These peak discharges were made up in part for the 14 square miles tributary to Mountain Brook and 15.7 square miles tributary to the large storage in Contoocook Lake. Comparison of the characteristics of these two tributary areas indicate that the major portion of the peak flows probably come from Mountain Brook. Therefore, peak discharge per square mile obtained on the basis of 36.1 square miles should be materially increased when applied to Mountain Brook. A peak value of 180 c.f.s. per square mile was used for the discharge of Mountain Brook at its confluence with the Contoocook River for the 1938 flood. Discharge records for other drainage areas nearby or adjacent have been studied for obtaining run-off characteristics. Records for the following stations were used in this connection.

Basin	Name of Stream	Station Location	Drainage Area	Max. Discharge c.f.s./sq.mi.
Merrimack	Contoocook River	East Jaffrey	36.1	99
	Nubanusit Brook	West Peterboro	45.2	92
	No. Branch Contoocook River	Antrim	54.8	85
	Warner River	Bradford	19.7	120
	Souhegan River	Greenville	29.9	206
	Stony Brook	Wilton	33.2	174
Connecticut	Moss Brook	Wendell Depot	12.2	126
	So. Branch Ashuelot River	Webb	36.6	163
	Otter Brook	Keene	41.8	147

5. Precipitation Records.- Precipitation records are available from nearby stations at Greenville, Peterboro, Keene, and Fitzwilliam, N.H., and Winchendon, Mass. There are no recording rain gages nearby, hence satisfactory mass curves of precipitation applicable to this small drainage area could not be obtained. The maximum intensity of rainfall known in this vicinity is the unofficial record for September 21, 1938, at Peterboro, when 9-1/2 inches of rainfall in two hours was observed.

6. Distribution Values.- An attempt was made to obtain distribution values applicable to Mountain Brook from an analysis of the 12.2-square-mile drainage area of Moss Brook, a nearby stream of similar characteristics and size, for which discharge records were obtainable. However, because of the lack of recording rainfall records, it was found that the effect of possible variations in the rainfall intensity values from estimated precipitation mass curves precluded any accurate determination of distribution values. The empirical method of deriving a unit graph, as outlined by Franklin F. Synder, (1938 Transactions, American Geophysical Union, Part I, pp. 447-454),

was used as the most rational method available. This method bases the unit graph fundamentally on the size and shape of the drainage basin. Values obtained by this method could not be checked against any available data for drainage areas less than 36 square miles. However, when applied to larger basins where the unit graph was previously obtained from rainfall and discharge records, it was found that Synder's empirical method gives a unit graph more peaked and with a shorter lag. Consequently, it was concluded that the unit graph derived empirically provided a reasonable criterion for distribution values for Mountain Brook Reservoir. Review of these data by the Office, Chief of Engineers, showed that the volume of the computed flood was adequate but that peak inflow was too small to be accepted for the spillway design flood. Therefore, a unit hydrograph was proposed with a peak value of 2,240 c.f.s. to be applied to rainfall values in excess of those from which the basic unit graph was derived. The recommended unit graph applicable to the two maximum periods of rainfall is shown on Plate 16, together with the unit graph derived for the basic flood and used for lesser periods of rainfall.

7. Maximum Storm.- Study of the summer-fall and winter-spring rainfall values showed that a more severe spillway flood is obtained from summer-fall limiting rates of rainfall. A storm of 24-hour duration was used. The intensity curve for a 14-square-mile area was obtained from limiting precipitation values as furnished by the Hydro-Meteorological Section of the U. S. Weather Bureau and shown on Plate 13. These curves were also used to obtain precipitation data for the hydrology analysis of Blackwater Reservoir and the Hopkinton-Everett Reservoir. The values used for the proposed Mountain Brook Reservoir were substantiated by a recent report on the "Maximum Possible Precipitation over the Ompompanoosuc Basin above Union Village, Vermont," prepared by the Hydro-Meteorological Section of the Weather Bureau (March 18, 1940). Plate 14 is a reproduction of "Enveloping Duration-Depth Curves of Maximum Possible Rainfall over Selected Basins in the New England Region," as contained in that report. The duration-depth curve used for Mountain Brook Reservoir has also been plotted on Plate 14, using values taken from Plate 13 up to 18 hours with the 24-hour value made comparable to the similar value for the given curves in Plate 14. The precipitation values used for Mountain Brook drainage area of 14 square miles are considered adequate. The data concerning the winter storm with snow run-off conditions as discussed in this report were also checked. It was ascertained that the intensity of summer precipitation caused the severest flood and hence should be used for spillway design criteria.

8. Computed Spillway Flood.- The computed spillway flood was based on the distribution values obtained from the basic unit graph (Plate 16) and the rainfall data (Plate 13). For a summer storm, the minimum infiltration rate was assumed to be 0.083 inch per hour,

or 0.25 inch per three-hour period. This is somewhat less than the average rate of 0.087 inch per hour determined from a study of the September 1938 flood, when ground conditions prior to the flood were conducive to minimum infiltration rates due to excessive rainfall during the first three weeks in September. Computations for the spillway flood are shown on Plate 17.

Determination of Spillway Design Flood

9. Reservoir Operation Assumptions.- It is assumed that the reservoir will be filled to normal maximum pool elevation of 1026 feet M.S.L., the crest of the spillway, at the beginning of the spillway design flood. It is further assumed that the outlet is inoperative.

10. Spillway Rating Curve.- The spillway rating curve was computed by the weir formula $Q = CLH^{3/2}$ and checked by model studies. The curve used in this design is shown by the solid line curve, Plate 21. (Also, see Appendix B.)

11. Method of Routing.- The unit graph is considered as an inflow to the reservoir, consequently the flood was routed through the reservoir using the gross surcharge storage.

12. Spillway Design Flood.- The computed spillway flood was routed through the reservoir to obtain the reservoir discharge and the maximum water surface elevation. The inflow ordinates of the computed spillway flood were then increased 25 and 50 percent and similarly routed through the reservoir. The results of these routings are shown graphically on Plate 19, where the percent of computed spillway flood is plotted (a) against the pool elevation in feet above mean sea level, and (b) against the peak inflows and outflows. The volume of the computed flood was considered adequate but the inflow peak values, too small. Therefore, the effect of increasing the peak values of the hydrograph,using a constant volume for the computed flood, was determined as shown on "Curve P", Plate 19. The inflow hydrographs were computed by applying the basic unit graph to all but the two periods of greatest run-off. The peaked unit graph was applied to the two periods of maximum run-off. The selected spillway design flood hydrograph was obtained by applying the two unit graphs of Plate 16 to the proper values of rainfall shown on Plate 18. The resulting spillway design flood inflow and outflow hydrographs, with reservoir stage elevations, are shown on Plate 25. These resulting values are those recommended by the Office, Chief of Engineers, and include an inflow peak greater than recorded maximum flood peaks for the northeastern United States as shown on Plate 15. Data pertaining to the adopted spillway design flood

are summarized as follows:

Rainfall	21.05 inches in 24 hours
Run-off	19.05 inches
Volume	14,200 acre-feet
Peak inflow	29,500 c.f.s.
Peak outflow	15,800 c.f.s.
Maximum pool elevation	1038.8
Freeboard	3.2 feet

13. Adequacy of Selected Spillway Design Flood.- (a) A study was made of the latest data available for maximum rainfall in New England as compiled by the U. S. Weather Bureau in the report on "The Maximum Possible Precipitation over the Ompompanoosuc River Basin above Union Village, Vermont," dated March 18, 1940. This study indicated that the point rainfall values used as given in Plate 13 equalled or exceeded values given in Fig. 24 of the Ompompanoosuc report for maximum recorded point rainfall in the United States. Likewise, the values in Plate 13 for a 100-square-mile area equal similar values given in this report for which reliability factors were applied to obtain maximum possible rainfall. Interpolation for 14 square miles between the point and 100-square-mile values is believed to have been conservative. Therefore, no factor of safety is considered necessary to increase the rainfall values used in the spillway design flood.

(b) The average infiltration rate used of 0.083 inch per hour, or 0.25 inch per three-hour period is low enough to justify elimination of a factor of safety for the assumed run-off conditions.

(c) The unit graph and distribution values originally derived gave a peak value of 860 c.f.s. or 61 c.f.s. per square mile for one inch of run-off in 3 hours. On recommendation of the Office, Chief of Engineers, the 3-hour unit graph was peaked up to give 2,240 c.f.s. or 160 c.f.s. per square mile. These values are believed sufficiently high to offset errors inherent in their selection.

(d) The area-capacity curve (Plate 12) is based on actual field surveys of several reservoir cross-sections, tied into the topographic survey published by the U. S. Geological Survey, and is considered reasonably accurate.

(e) The spillway design flood has a volume of 14,200 acre-feet (19.05 inches) with a peak inflow of 29,500 c.f.s. or 2,110 c.f.s. per square mile. An index of the magnitude of this flood is given by the value of 7,900 for the coefficient "C" in the relation $Q = C\sqrt{A}$. This peak is greater than any discharge observed in the northeastern United States for a comparable drainage area. (See Plate 15.)

(f) The spillway is the overflow type with sufficient discharge channel capacity to prevent appreciable backwater up to about 125% of the spillway design flood. No factor of safety is considered necessary on this account.

(g) A large volume of surcharge storage is available above the spillway lip. The surcharge storage from spillway lip (Elev. 1026) to maximum computed water surface (Elev. 1038.8) is 7.9 inches. There is an additional 2.8 inches between Elev. 1038.8 and the top of the dam. Hence, the total volume of surcharge storage between spillway crest (Elev. 1026) and top of dam (Elev. 1042) is equivalent to 10.7 inches of run-off over the 14 square miles of drainage area. This is considered an ample factor of safety.

14. Freeboard.- The computed maximum water surface for the selected spillway design flood is Elev. 1038.8. After consideration of the following factors in conference with representatives of the Office, Chief of Engineers, it was decided to place the top of dam at Elev. 1042, thus providing 3.2 feet of freeboard:

(a) The maximum stage would be of extremely short duration, due to the highly peaked inflow hydrograph. With the top of dam at Elev. 1042, the freeboard will be as little as 3.2 feet for less than an hour, 4 feet for less than 2 hours, and 5 feet for 3-1/2 hours.

(b) The top of dam will be protected by a 22-foot wide paved highway, thus minimizing danger of damage from wave action.

(c) Even if the dam should fail, flood conditions downstream would not be seriously aggravated. The flood level at East Jaffrey, one mile downstream, would be increased only 2 to 3 feet.

DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

APPENDIX B

HYDRAULICS

1. Outlets.- As the reservoir controls such a small drainage area and will be utilized for flood control only, it was decided to design the reservoir as a simple retarding basin in order to eliminate operation and the cost of gates, operating house, and appurtenances. The criteria for the outlet design were as follows:

1. To adequately reduce flood flows.
2. To have sufficient capacity to empty the reservoir in a reasonable period of time.
3. To pass normal flow without excessive dead storage.
4. To provide sufficient capacity for diversion during construction.

2. With the six inches of storage provided and the reservoir design flood criteria as used for other reservoir studies in the Merrimack River Basin (see "Definite Project Report for Blackwater Reservoir" dated September 15, 1939, revised December 16, 1939, for a discussion of the reservoir design flood), it was found that a maximum capacity of 250 c.f.s. was necessary for controlling the flood without spillway discharge. However, to meet the other three criteria it was considered advisable to increase this discharge capacity to about 360 c.f.s. The channel capacity below the dam can pass the peak discharge of 360 c.f.s. plus any anticipated flow from Contoocook Lake. The outlet capacity provided permits the reservoir to empty in 13 days (see Plate 24). This is believed to be a satisfactory adjustment of the criteria enumerated in paragraph 1. Assuming an ordinary flow of 70 c.f.s., (5 c.f.s. per square mile), the pool elevation is 1009 with a resulting dead storage of 300 acre-feet. Computations indicate that with invert at Elev. 1005 and spillway at 1026, an outlet area of 16 square feet is required. Frictional losses were computed using an "n" value of 0.013 in Chezy's Formula. Intake area was made sufficiently large to keep the intake velocities low and provide excess capacity through the trashracks, in order to minimize the effect of collecting debris.

3. As the maximum discharge velocity will be about 23 feet per second, and as there is no indication of rock for providing a safe discharge channel, it is essential to include a stilling basin to dissipate the discharge energy. Tailwater conditions are variable and dependent on the operation of the dam in East Jaffrey, one mile downstream (Plate 22). For a normal tailwater at Elev. 1005, and a discharge of 360 c.f.s., the hydraulic jump is obtained with a stilling

basin 16 feet wide and theoretical depth of flow equal to 6-1/2 feet. A secondary control exists midway between Mountain Brook Dam and the East Jaffrey Dam, formed by a constricted channel containing boulders of various sizes and protected against excessive velocities by backwater from the East Jaffrey Dam. A rating curve at Mountain Brook Dam for this control is shown as a dashed line on Plate 22 and was derived from flood profile data obtained after the September 1938 flood with East Jaffrey Dam washed out. However, any uncertainty in stilling basin action due to variable tailwater will be eliminated by setting the stilling basin floor at Elev. 997. With the end sill at Elev. 999, the minimum depth of flow over the end sill and riprapped channel for 360 c.f.s. will provide adequate depth in the stilling basin for the hydraulic jump, regardless of downstream conditions. In the remote possibility of an excessive spillway discharge, high tailwater will "drown out" the hydraulic jump of the outlet discharge and the jet may persist downstream from the outlets to be dissipated in the flooded valley. Eddy currents set up by this discharge condition will not endanger the dam embankment section.

4. Spillway.- The spillway for the Mountain Brook Dam consists of a concrete control weir and discharge flume in a cut through the left abutment. The approach to the weir is a trapezoidal section with a bottom width of 130 feet at Elev. 1019 and side slopes of 1 on 2 (Plate 4). This section is slightly larger than required for the spillway capacity, but the excavated material can be advantageously used in the embankment. As a result, the mean velocity in the approach channel is only 5 feet per second for the spillway design flood, which minimizes the scouring and the entrance losses. A 100-foot concrete weir with crest at Elev. 1026 establishes the hydraulic control for all discharges. From the toe of the weir, at Elev. 1023, a concrete discharge channel with an invert slope of 6-2/3% converges to a width of 65 feet and carries the discharge to a stilling basin. The stilling basin floor is at Elev. 998. The width of the stilling basin increases from 65 feet to 90 feet at its downstream end, reducing the discharge velocity to a safe value before entering the Contoocook River.

5. The spillway rating curve (Plate 21) was based originally on computations of the pond elevation for discharge over the control weir, using the weir formula $Q = CLH^{3/2}$ with values of "C" varying from 3.0 to a maximum of 3.8. The discharge channel below the weir was designed originally for a capacity of 10,000 c.f.s. and minimum width at the restricted section of 50 feet. An hydraulic model study indicated that this design proved adequate for this capacity. However, increasing the discharge requirements to 15,800 c.f.s. necessitated widening the discharge channel to 65 feet to insure that the channel constriction would not cause a secondary hydraulic control or cause overtopping the side walls. The spillway rating curves shown on Plate 21 are, (1) the original computed rating

curve, (2) the discharge rating curve obtained by the model study, and (3) the curve based on the model study plus computations for the 65-foot minimum channel width at the bridge.

6. Tailwater Rating Curve.- The tailwater rating curve (Plate 22) is based on a computed rating of the concrete dam at East Jaffrey about one mile downstream. The spillway of this dam is at Elev. 1002.95 with flashboards at 1004.86. Two large sluice gates are located in the abutments. Allowance is made for backwater from East Jaffrey to the Mountain Brook dam site. Also shown is the estimated tailwater rating for the natural control between East Jaffrey and Mountain Brook. For normal operations, and for flows up to about 3000 c.f.s., the tailwater rating based on this dam is satisfactory. For a spillway design discharge, the tailwater elevation is dependent on the surcharge storage above Contoocook Lake Dam and on the discharge capacity of the East Jaffrey Dam, since tailwater elevations above 1010 are the result of water in Contoocook River backing up into Contoocook Lake. After due consideration of these factors, the tailwater elevation with the spillway design flood is estimated to be about 1020.

7. Time of Emptying.- The time necessary to empty the reservoir with the pool initially at Elev. 1026 (spillway crest) and a constant inflow of 70 c.f.s. (5 c.f.s. per square mile) is 13 days (see Plate 24). It should be noted that, in emptying the reservoir, 2 inches of storage becomes available in three days, and 4 inches, or two-thirds of the total capacity, is available in 6 days.

8. Effect of Mountain Brook Reservoir.- The effect of Mountain Brook Reservoir on the estimated September 1938 flood at the dam site is shown on Plate 23. The volume of run-off and timing of the peak is based on flood hydrographs observed on small streams located in the adjacent Connecticut River Basin near Keene, N. H. The peak of the flood is estimated as the probable discharge necessary to obtain the computed peak of 3560 c.f.s. in East Jaffrey. The maximum pool elevation obtained by routing this flood is Elev. 1026.5, with a conduit discharge of 370 c.f.s. and a spillway discharge of 150 c.f.s. It is estimated that this would have reduced the 1938 peak flow in East Jaffrey from 3560 to about 1500 c.f.s. The March 1936 flood would have been reduced from 2580 to about 1100 c.f.s.

DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

MERRIMACK RIVER BASIN FLOOD CONTROL

APPENDIX C

GEOLOGY AND SOIL DATA

1. Description of Dam Site.- The Mountain Brook dam site is located approximately one mile south of East Jaffrey, N.H., at the bridge which carries U.S. Highway No. 202 over Mountain Brook (see Plate 2). The dike site is located across the saddle adjacent to the right abutment of the dam. The region at the site has relatively low relief, with low hills of glacial till rising above the broad swampy valley which is filled with variable glacial and fluvio-glacial materials. Mountain Brook meanders in this valley to its confluence with the Contoocook River, which is about 500 feet below the dam site.

2. The overburden in the abutments of the dam site consists generally of sandy glacial till varying in depths from 5 to 20 feet which overlies a very silty glacial till.* The stream channel has a variable deposit of gravel over silty till. The silty till extends to bedrock, which in general is granite varying to gneiss with numerous schist inclusions and fractured joints. Bedrock in general is below Elev. 995. Upstream and downstream on the lower slopes of the right abutment the silty glacial till is more than 30 feet below the ground surface. The overburden in the valley upstream and downstream from the dam site consists of muck overlying till. The depth of the muck in the proposed area for the base of the dam averages approximately 3 feet thick. Beyond 200 feet upstream from the bridge the muck varies in depth from 5 to 11 feet. The deepest deposit downstream is apparently 150 feet from the bridge near the south bank of the stream and is approximately 12 feet deep. The sandy glacial till and silty glacial till within the proposed foundation area have characteristics similar to the pervious and impervious material for the embankment sections as described in paragraphs 6(a) and 6(b) below.

3. Description of Dike Site.- On the lower slopes of both abutments of the dike site and in the proposed area for the base of the dike, deposits of gravelly sand occur (see Plate 8). These sand deposits are approximately 35 feet deep and overlie glacial till. The higher slopes of the hills forming the abutments are blanketed by thin deposits of sandy till which cover silty glacial till, probably extending to rock. Rock is deeply buried over the entire dike site. The sandy and silty tills forming the abutments of the dike are similar to the tills of the dam site. The gravelly sand in the bottom of the saddle is somewhat stratified and has an estimated coefficient of per-

*See Plate 8.

meability varying from 10 to 100×10^{-4} cm. per second and an angle of internal friction of 36 degrees. Grain-size curves of samples taken from drill hole D6 in this deposit are shown on Plate 9.

4. Dam and Dike Sites Exploration.- The exploration of the foundation for the dam and dikes and appurtenant structures included the drilling of 13 holes, excavating of 8 test pits, extensive augering and probing, and the determination of rock elevations by two seismic lines. The locations of the drill holes and test pits are shown on Plates 5 and 6 and the logs of the drill holes on Plate 7. The augering and probing was done in the flat region of the valley bottom extending 300 feet upstream and 500 feet downstream from the highway bridge.

5. Borrow Materials.- Exploration to locate suitable materials for the dam and dike embankments required beyond quantities available from structure excavation included the drilling of one hole, the excavation and sampling of 11 test pits, and the examination of all exposed faces of natural overburden in the vicinity. The location of the test pits and drill holes within the detailed survey area are shown on Plates 5 and 6.

6. Suitable materials are available within an economic distance from the dam and dike sites for the construction of embankments by the rolled fill method. Materials for the pervious and impervious sections are available from the structure excavations and borrow areas adjacent to the dam and dike sites. Sand and gravel for the drainage toes and upstream slope drains is available 3-1/2 miles north of the site. Rock for riprap is available from an outcropping area 3 miles north of the site and from stone fences within the reservoir area. The general characteristics of the materials for the proposed embankment construction as determined from preliminary investigations are as follows:

(a) Pervious Material.- The pervious material available from the structure excavations and the two borrow areas is a well-graded, slightly silty, sand and gravel glacial till. The pervious material in the structure excavation areas for the outlets and spillway, and in the borrow area adjacent to the proposed dam site, varies in depth from 10 to 25 feet. In the borrow area adjacent to the dike the pervious material varies in depth from 5 to 10 feet. Typical grain-size curves of samples of the pervious material are shown on Plate 11. It is estimated that the material, when compacted, will have a coefficient of permeability from 1×10^{-4} to 10×10^{-4} cm. per second and an angle of internal friction of 38 degrees.

(b) Impervious Material.- Material for the impervious sections of the embankments is available from the spillway excavation and the two borrow areas shown on Plates 5 and 6. The material in all areas is overlain by pervious material as described above. The impervious material is a well-graded, very silty, sand and gravel glacial till.

Typical grain-size curves are shown on Plate 10. It is estimated that the material, when compacted in the embankment will have a coefficient of permeability less than 0.01×10^{-4} cm. per second and an angle of internal friction of 36 degrees, with very slight cohesion.

(c) Sand and Gravel.- The available material which is suitable for the drainage toes is a clean, gravelly sand. It is estimated that less than 20% by weight of the material is greater than 1/4" in size. The amount of sand and gravel required for concrete aggregates is relatively small. It is expected that it will be more economical to obtain this material from commercially developed sand and gravel banks located within an economic hauling distance from the proposed work.

(d) Rock.- The rock available for riprap in the outcropping area is a porphyritic granite gneiss. The rock in the stone fences in the vicinity is in general either a granite gneiss or sound schist.

DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

MERRIMACK RIVER BASIN FLOOD CONTROL

APPENDIX D

SELECTION OF STRUCTURE

1. Selection of Type and Arrangement of Structures.- The retaining structures of the Mountain Brook Dam consist of two embankments, a dam embankment across the river valley having a crest length of 1000 feet and a maximum height of 45 feet, and a dike embankment across an adjoining saddle 700 feet long and 30 feet in greatest height. (See Plate 3.) The spillway is a concrete-lined channel having a crest width of 100 feet converging to a chute width of 65 feet excavated in the glacial till overburden of the left abutment of the dam and discharging in a location remote from the embankment. The outlet works consist of a single uncontrolled reinforced concrete conduit placed in a cut through the undisturbed glacial till overburden of the left abutment and discharging into a stilling basin located sufficiently remote from the toe of the embankment. The conduit is rectangular in shape, 3'-6" wide by 4'-9" high. Trash-bars are placed at the conduit intake.

2. The arrangement of the structures described above was selected as being the most economical adapted to the site. Material excavated for the spillway and outlets is suitable for fill in the embankments. Quantities of suitable fill beyond the amounts available from this source can be secured from immediately adjacent borrow pits. The compacted till of the left abutment provides a suitable foundation for the spillway and outlet in the absence of readily accessible bedrock. The location of the outlets permits the development of a straightforward program of stream diversion and embankment construction.

3. The centerline of the dam embankment is approximately coincidental with the present location of U.S. Highway No. 202. The reconstructed highway will be carried across on the crest of the dam embankment, which is provided with a top width of 32 feet for this purpose. The existing bridge over the stream will be removed and a new bridge constructed across the spillway channel.

4. Preliminary Design of Embankments.- Based on the preliminary investigations of borrow materials and the embankment foundations, as described in the foregoing paragraphs, a tentative design of the embankments for the dam and dike have been prepared as shown on Plate 4. The embankments are provided with impervious, pervious, and drainage features which are described in the following paragraphs.

(a) Impervious Features.- The upstream and central portions of the embankments consist of compacted impervious fill corresponding to the material described in paragraph 6(b) of Appendix C. A cut-off trench will be excavated under the impervious fill section of the dam extending into the impervious till foundation, except in the river bed section where the trench will be excavated to bedrock. Within this latter reach, a shallow cut-off curtain will be grouted in the rock. To reduce seepage through the foundation of the dike, an upstream impervious blanket will be constructed for the entire length of the structure, and in addition, a trench will be excavated under the upstream toe of the dam to a nominal depth of 5 feet as a general precaution against buried drains. This trench will serve also to form a seal with the impervious till foundation at the abutments of the dike. The upstream slope of the embankments is 1 on 4, which, it is believed, provides ample stability against slide failures and local sloughing.

(b) Pervious Features.- The downstream portion of both the dam and dike embankments consists of compacted pervious fill corresponding to the material described in Appendix C, paragraph 6(a). The relative proportions of the impervious and pervious fill sections of the embankments are tentative and will be adjusted upon further investigation of the relative quantities available from structure excavation and the borrow areas. The downstream slope of the embankments is 1 on 2-1/2 to Elev. 1018 and 1 on 3 below this elevation, which is believed to be entirely adequate from a consideration of the characteristics of the embankment fill and foundation materials and the low height of the embankments.

(c) Downstream Drainage Toe.- A small downstream drainage toe of sand and gravel, as described in paragraph 6(c) of Appendix C, is incorporated in the dike for protection against possible minor concentrations of seepage water. The surface of this drainage toe and a portion of the downstream slope of the dam embankment in the river bed will be protected from slope or wave washing by hand-placed riprap.

(d) Slope Protection.- A sod surface will be developed on both the upstream and downstream slopes. A sod surface on the upstream slope in lieu of rock protection is considered satisfactory because of the limited fetch of the reservoir (1.8 miles at the spillway), the flatness of the slope, and the natural resistance of the impervious till face to rapid erosion.

DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

APPENDIX E

COST ESTIMATE

The detailed cost estimate of the Mountain Brook Reservoir constructed for flood control purposes only is itemized in the following tabulation.

38 000 Includes 28%

I. RESERVOIR COSTS

	Quantity	Unit Price	Total Cost	
Land	lump sum	-	$ 19,000	30,000
Buildings	lump sum	-	11,000	
Highways	lump sum	-	25,000	20,000
Utilities	lump sum	-	2,000	
Rock fill - Contoocook Lake Dam	lump sum	-	2,500	
Sub-Total			$ 59,500	
Engineering, Appraisals, Overhead & Contingencies (35%±)			20,500	
TOTAL - RESERVOIR COSTS			$ 80,000	

II. CONSTRUCTION COSTS

		Quantity	Unit Price	Total Cost
(a)	Stream Diversion & Pumping	lump sum		$ 5,500
	Clearing & Grubbing	lump sum		4,000
	Removal of Highway Bridge	lump sum		2,200
	Stripping	32,000 c.y.	$ 0.40	12,800
	Common Excavation	73,400 c.y.	0.30	22,000
	Borrow - Impervious	71,000 c.y.	0.35	24,900
	Borrow - Pervious	43,100 c.y.	0.35	15,100
	Structure Backfill - Compacted	6,800 c.y.	0.35	2,400
	Structure Backfill - Uncompacted	7,300 c.y.	0.20	1,500
	Rolled Fill - Impervious	89,200 c.y.	0.12	10,700
	Rolled Fill - Pervious	69,000 c.y.	0.14	9,700
	Hand-Laid Riprap	1,400 c.y.	4.00	5,600
	Gravel Backing	1,050 c.y.	1.50	1,600
	Sand & Gravel Drains	6,600 c.y.	1.00	6,600
	Concrete:			
	Outlet Works - Conduit	165 c.y.	20.00	3,300
	Approach & Stilling Basins	235 c.y.	14.00	3,300
	Spillway - Walls	1,200 c.y.	14.00	16,800
	Floor Slab & Weir	2,250 c.y.	9.00	20,300
	Bridge Deck	250 c.y.	25.00	6,300
	Reinforcing Steel	300,000 lbs.	0.05	15,000
	Misc. Metal (weep holes, trash-bars)	lump sum	-	2,000
	Highway Surfacing	2,860 s.y.	3.50	10,000
	Highway Guard Rail	2,500 l.f.	0.40	1,000
	Seeded Topsoil	6.0 acres	1,000.00	6,000
	TOTAL - DAM, OUTLET & SPILLWAY			$ 208,600

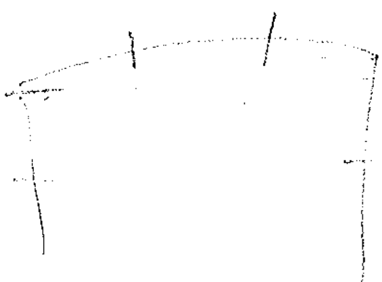
APPENDIX E

COST ESTIMATE (Cont'd.)

II. CONSTRUCTION COSTS (Cont'd.)

	Quantity	Unit Price	Total Cost
TOTAL - DAM, OUTLET & SPILLWAY (brot. fd.)			$ 208,600
(b) Reservoir Clearing	lump sum	-	6,000
Sub-Total - Construction Costs			$ 214,600
Engineering, Inspection, Overhead & Contingencies (35%±)			75,400
TOTAL - CONSTRUCTION COSTS			$ 290,000
TOTAL ESTIMATED COST			$ 370,000

208,600



DEFINITE PROJECT REPORT FOR MOUNTAIN BROOK RESERVOIR

APPENDIX F

INDEX TO PLATES

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2	Mountain Brook Reservoir
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4	Mountain Brook Dam - Sections
5	Plan of Exploration - Dam Site
6	Plan of Exploration - Dike Site
7	Record of Foundation Exploration
8	Geological Profiles on Centerlines of Dam and Dike
9	Grain-size Curve - Foundation Material - Dike Site
10	Grain-size Curve - Impervious Material - Dam & Dike Sites
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12	Area Capacity Curve
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20	Outlet Rating Curve
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23	Effect on September 1938 Flood
24	Time to Empty Reservoir
25	Spillway Design Flood - Inflow-Outflow-Stage Hydrographs

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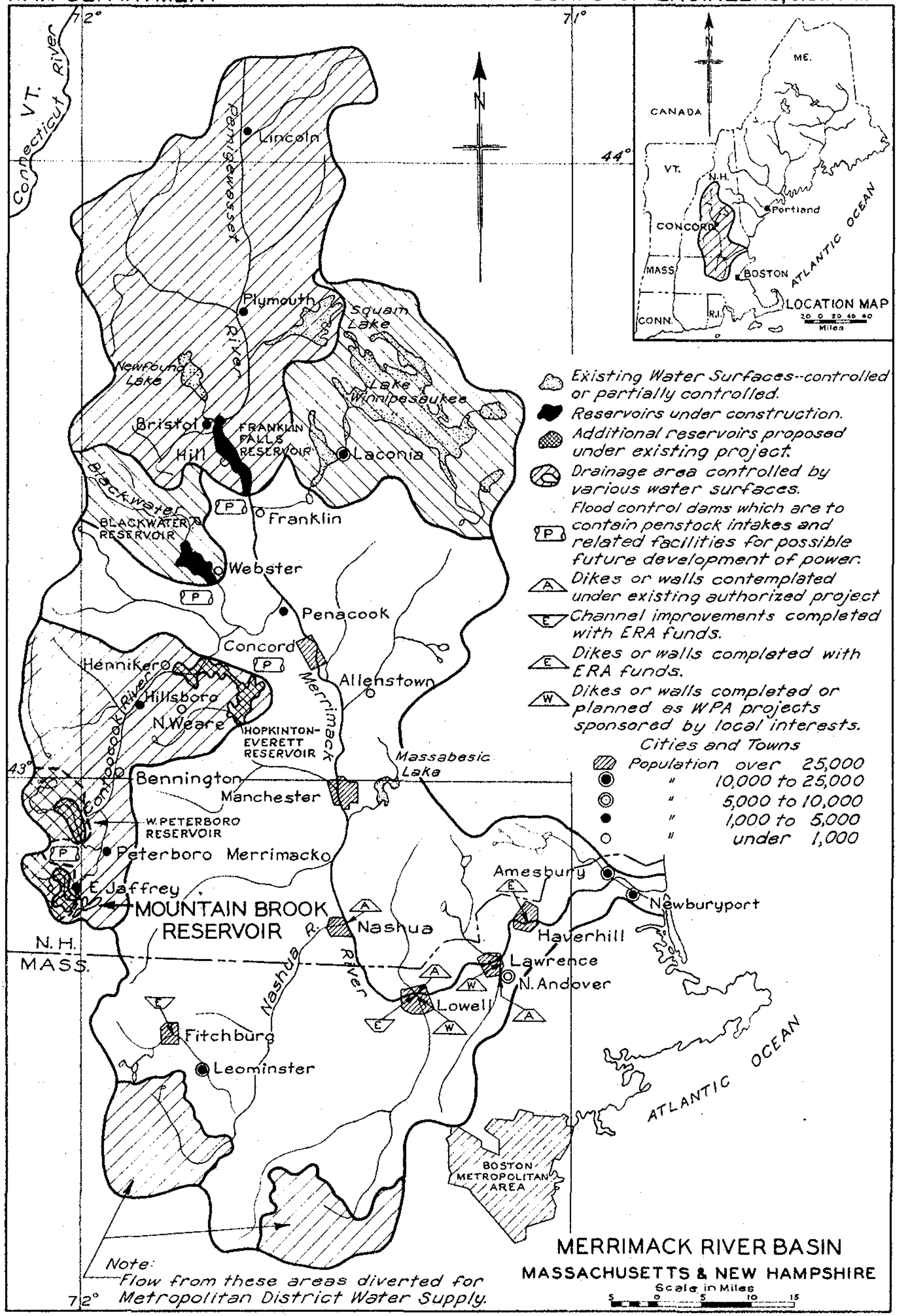
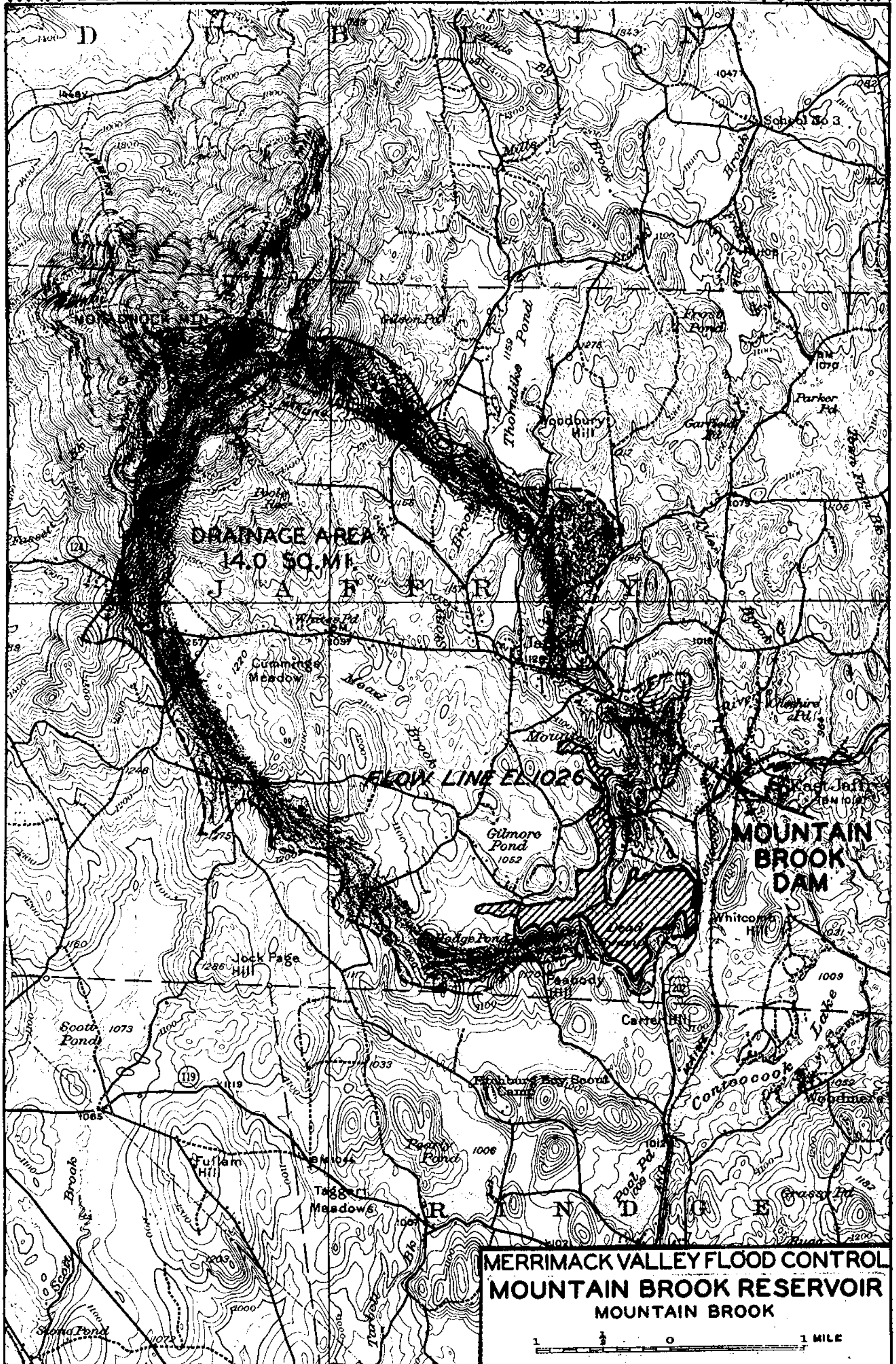


PLATE I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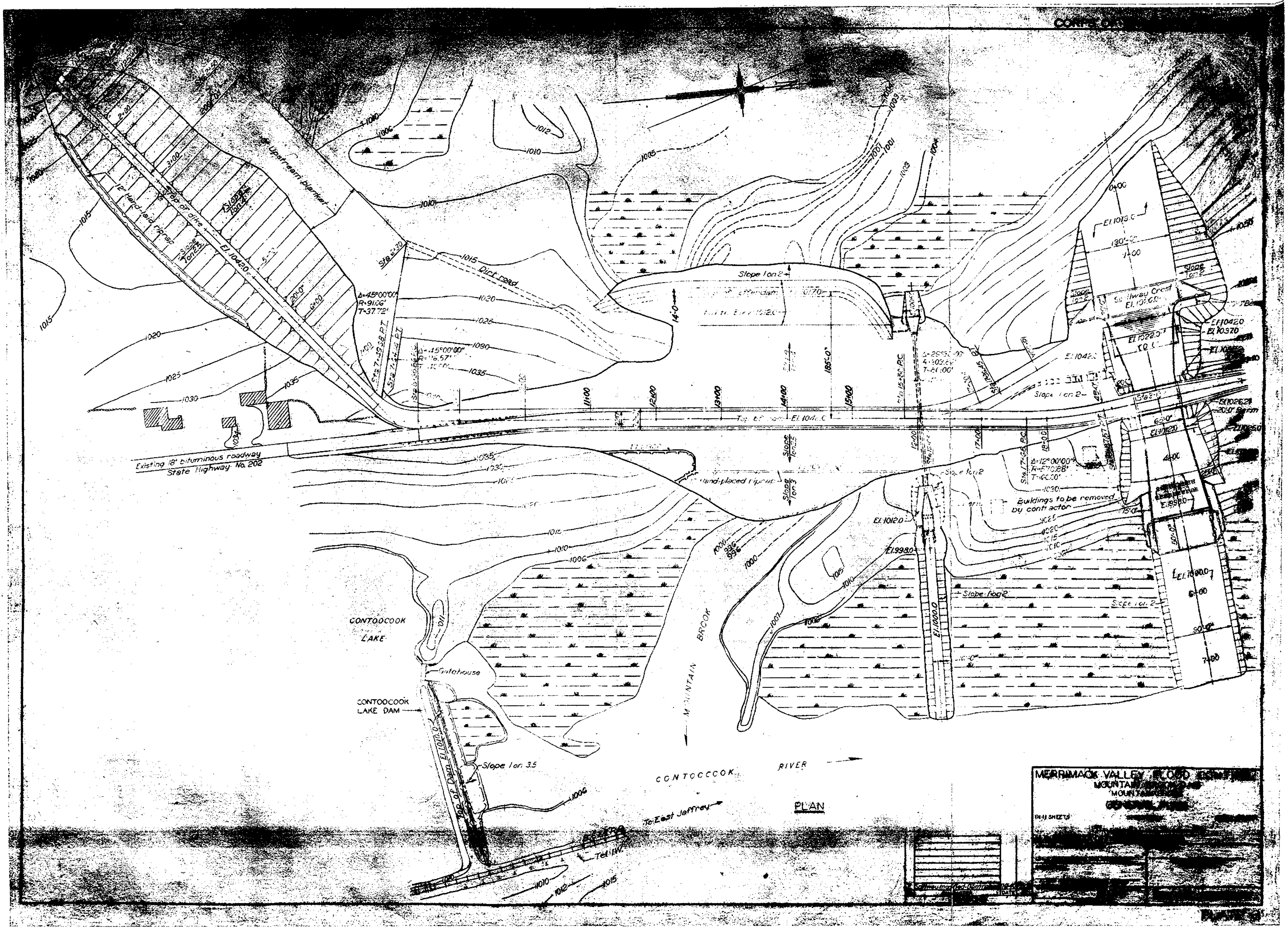
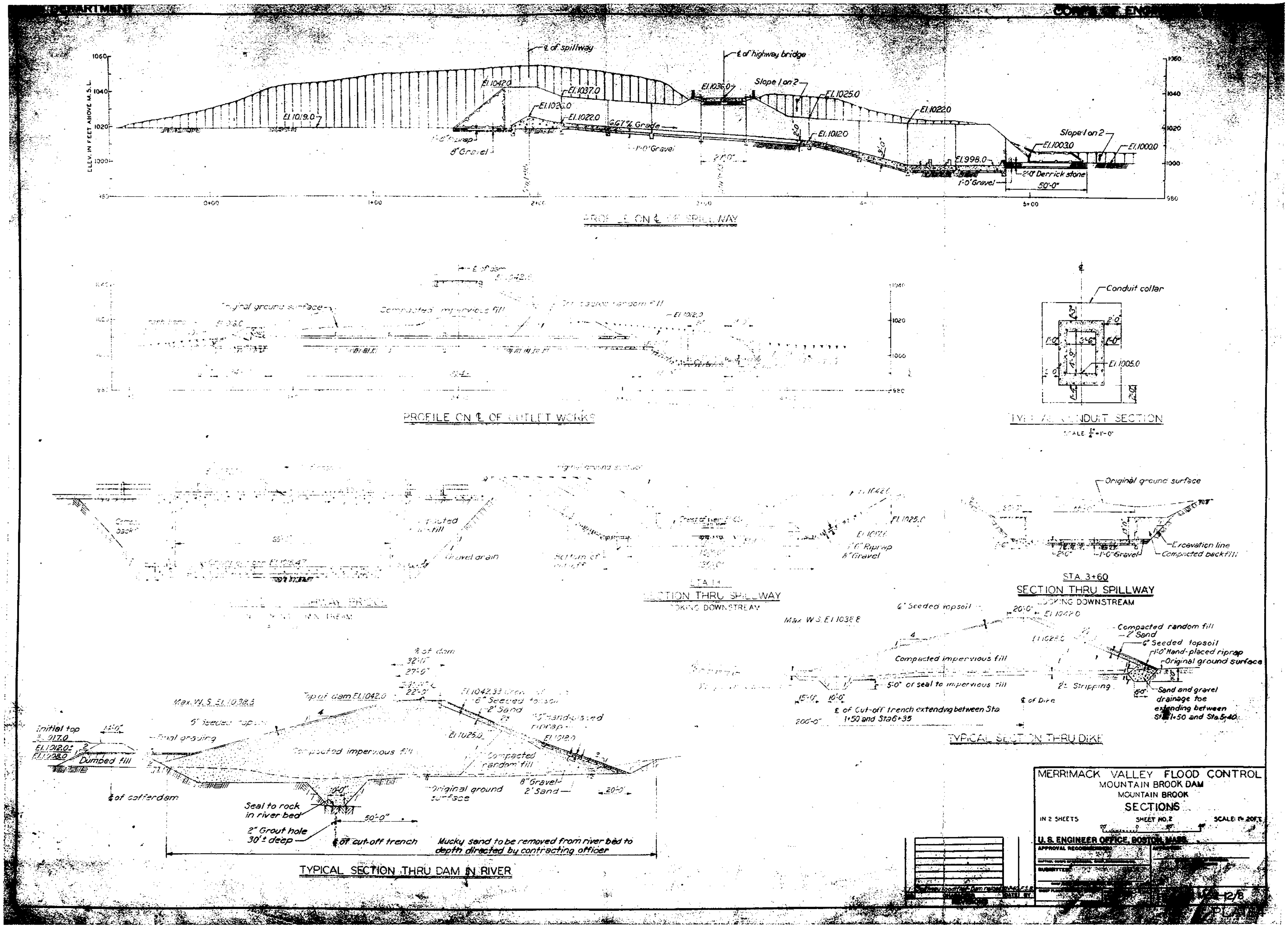
JAFFREY
RINDGE
MONADNOCK MTN.
Thorndike Pond
Gilmore Pond
Contoocook Lake
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
MOUNTAIN BROOK
1 ½ 0 1 MILE

PLATE 2



Upstream blanket
Top of dike
El. 1042.0
12" Hand-laid riprap
Dirt road
Existing 18' bituminous roadway
State Highway No. 202
Top of dam El. 1046.0
Hand-placed riprap
Buildings to be removed by contractor
Spillway Crest
CONTOOCOOK LAKE
Gatehouse
CONTOOCOOK LAKE DAM
Slope 1 on 3.5
MOUNTAIN BROOK
CONTOOCOOK RIVER
To East Jaffrey
PLAN
MERRIMACK VALLEY FLOOD CONTROL


DEPARTMENT
CORPS OF ENGINEERS
℄ of spillway
℄ of highway bridge
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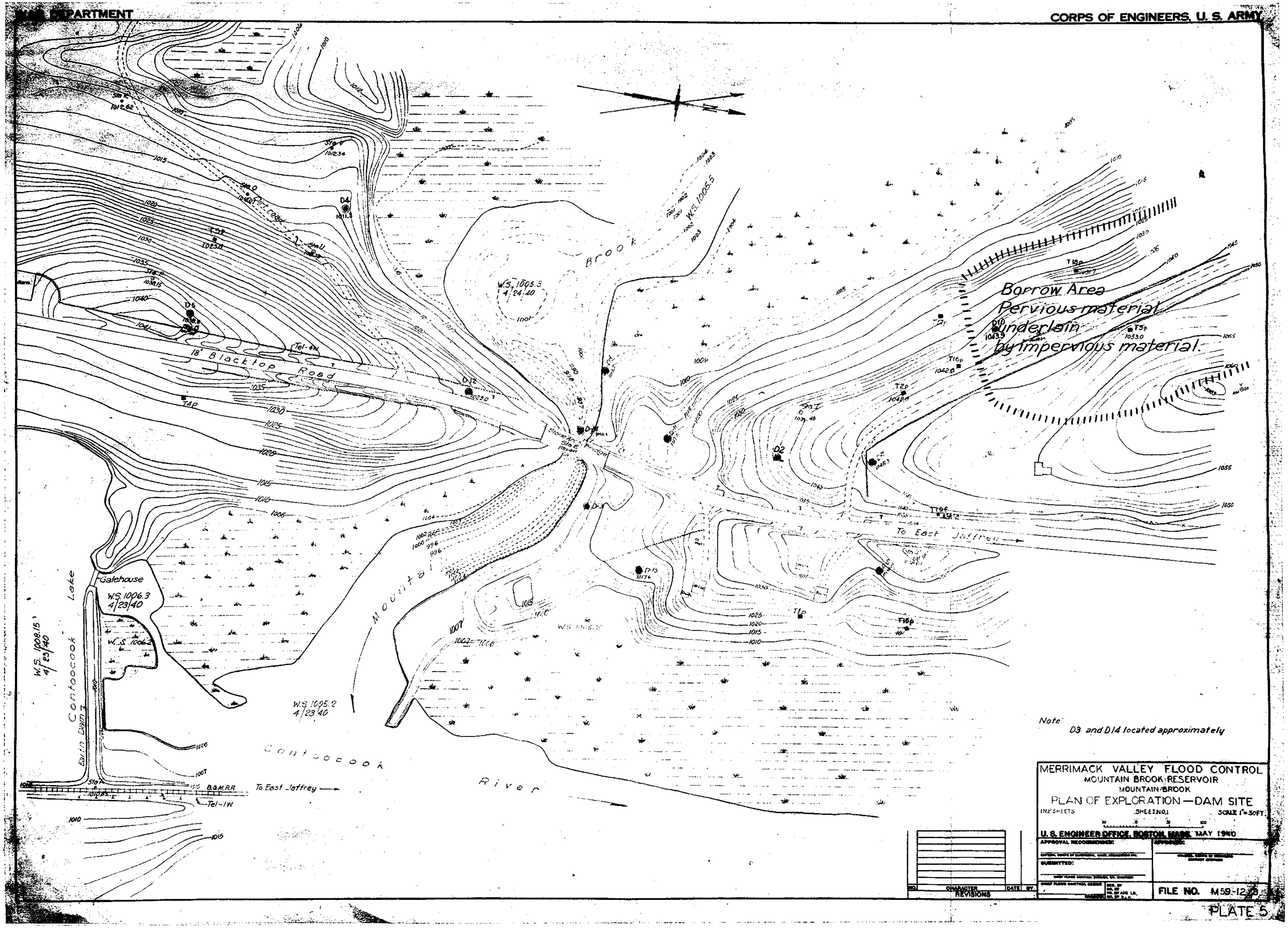
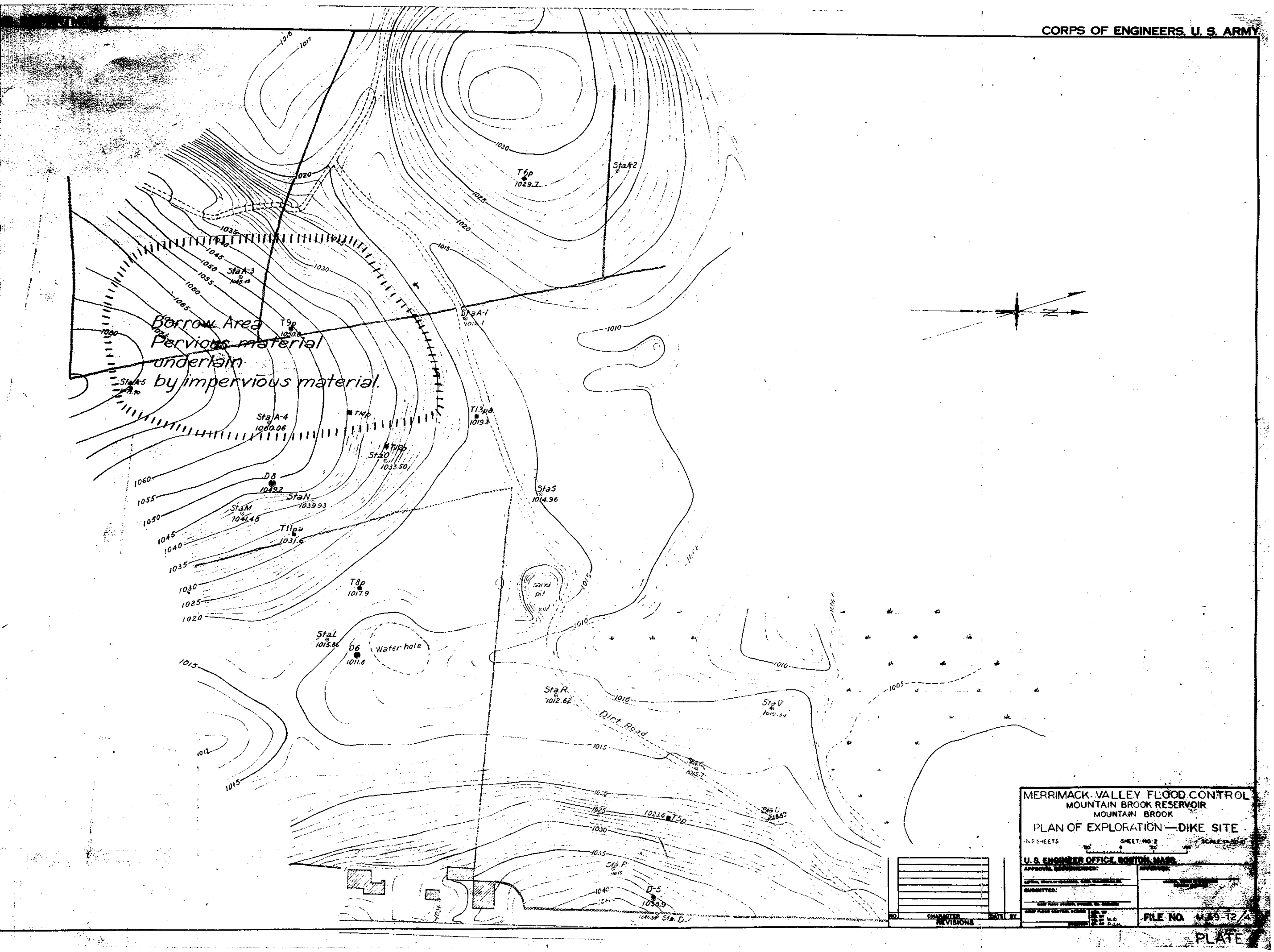
El. 1037.0
El. 1036.0
El. 1036.0
El. 1022.0
El. 1019.0
Slope 1 on 2
El. 1025.0
El. 1022.0
El. 1012.0
El. 998.0
El. 1003.0
El. 1000.0
Slope 1 on 2
6.67% Grade
1'-0" Riprap
8" Gravel
1'-0" Gravel
2'-0" Derrick stone
1'-0" Gravel
50'-0"
ELEV. IN FEET ABOVE M.S.L.
PROFILE ON ℄ OF SPILLWAY
Original ground surface
Compacted impervious fill
Compacted random fill
PROFILE ON ℄ OF OUTLET WORKS
Conduit collar
El. 1005.0
TYPICAL CONDUIT SECTION
Original ground surface
Gravel drain
El. 1042.0
El. 1025.0
1'-0" Riprap
8" Gravel
SECTION THRU SPILLWAY
LOOKING DOWNSTREAM
Original ground surface
Excavation line
Compacted backfill
1'-0" Gravel
STA. 3+60
SECTION THRU SPILLWAY
LOOKING DOWNSTREAM
6" Seeded topsoil
Max. W.S. El. 1038.8
El. 1042.0
Compacted random fill
2' Sand
6" Seeded topsoil
1'-0" Hand-placed riprap
Original ground surface
Compacted impervious fill
5'-0" of seal to impervious fill
2± Stripping
Sand and gravel drainage toe extending between Sta. 1+50 and Sta. 5+40
℄ of Cut-off trench extending between Sta. 1+50 and Sta. 6+35
℄ of Dike
TYPICAL SECTION THRU DIKE
℄ of dam
32'-0"
27'-0"
22'-0"
Max. W.S. El. 1038.8
Top of dam El. 1042.0
El. 1042.33
6" Seeded topsoil
2' Sand
Hand-placed riprap
Initial top El. 1017.0
El. 1012.0
El. 1008.0
Dumped fill
Final grading
Compacted impervious fill
El. 1025.0
El. 1018.0
Compacted random fill
8" Gravel
2' Sand
Original ground surface
℄ of cofferdam
Seal to rock in river bed
2" Grout hole 30'± deep
50'-0"
℄ of cut-off trench
Mucky sand to be removed from river bed to depth directed by contracting officer
TYPICAL SECTION THRU DAM IN RIVER
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK DAM
MOUNTAIN BROOK
SECTIONS
IN 2 SHEETS
SHEET NO. 2
U. S. ENGINEER OFFICE, BOSTON, MASS.


WAR DEPARTMENT
CORPS OF ENGINEERS, U.S. ARMY
Borrow Area
Pervious material underlain by impervious material.
18' Blacktop Road
Dirt road
Brook
W.S. 1005.5
W.S. 1005.3
4/24/40
Stone Arch Bridge
To East Jaffrey
Mountain Brook
Gatehouse
W.S. 1006.3
4/23/40
W.S. 1006.2
W.S. 1008.15
4/23/40
Contoocook Lake
Earth Dam
W.S. 1005.2
4/23/40
Contoocook River
B.&M.R.R.
To East Jaffrey
Tel-1W
Tel-4W
Note: D3 and D14 located approximately
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
MOUNTAIN BROOK
PLAN OF EXPLORATION — DAM SITE
IN 2 SHEETS
SHEET NO. 1
SCALE 1" = 50 FT.
U.S. ENGINEER OFFICE, BOSTON, MASS. MAY 1940
APPROVAL RECOMMENDED:
SUBMITTED:
APPROVED:
NO.
CHARACTER
REVISIONS
DATE
BY
FILE NO. M59-12/3
PLATE 5


CORPS OF ENGINEERS, U. S. ARMY
Borrow Area
Pervious material underlain by impervious material.
Sta A-2
T6p
1029.7
Sta A-3
T9p
1050.8
Sta A-1
Sta A-5
Sta A-4
1060.06
T14p
T13pa
1019.3
T1Rp
Sta O
1033.50
D8
1049.2
Sta N
1039.93
Sta M
1041.48
T11pa
1031.6
Sta S
1014.96
T8p
1017.9
sand pit
Sta L
1015.86
D6
1011.8
Water hole
Sta R
1012.62
Dirt Road
Sta V
Sta U
T5p
Sta P
D-5
1038.9
Sta D
N
REVISIONS
DATE
BY
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
MOUNTAIN BROOK
PLAN OF EXPLORATION — DIKE SITE
IN 2 SHEETS
SHEET NO. 2
U. S. ENGINEER OFFICE, BOSTON, MASS.
APPROVED:
SUBMITTED:
FILE NO. M-59-12/4
PLATE

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

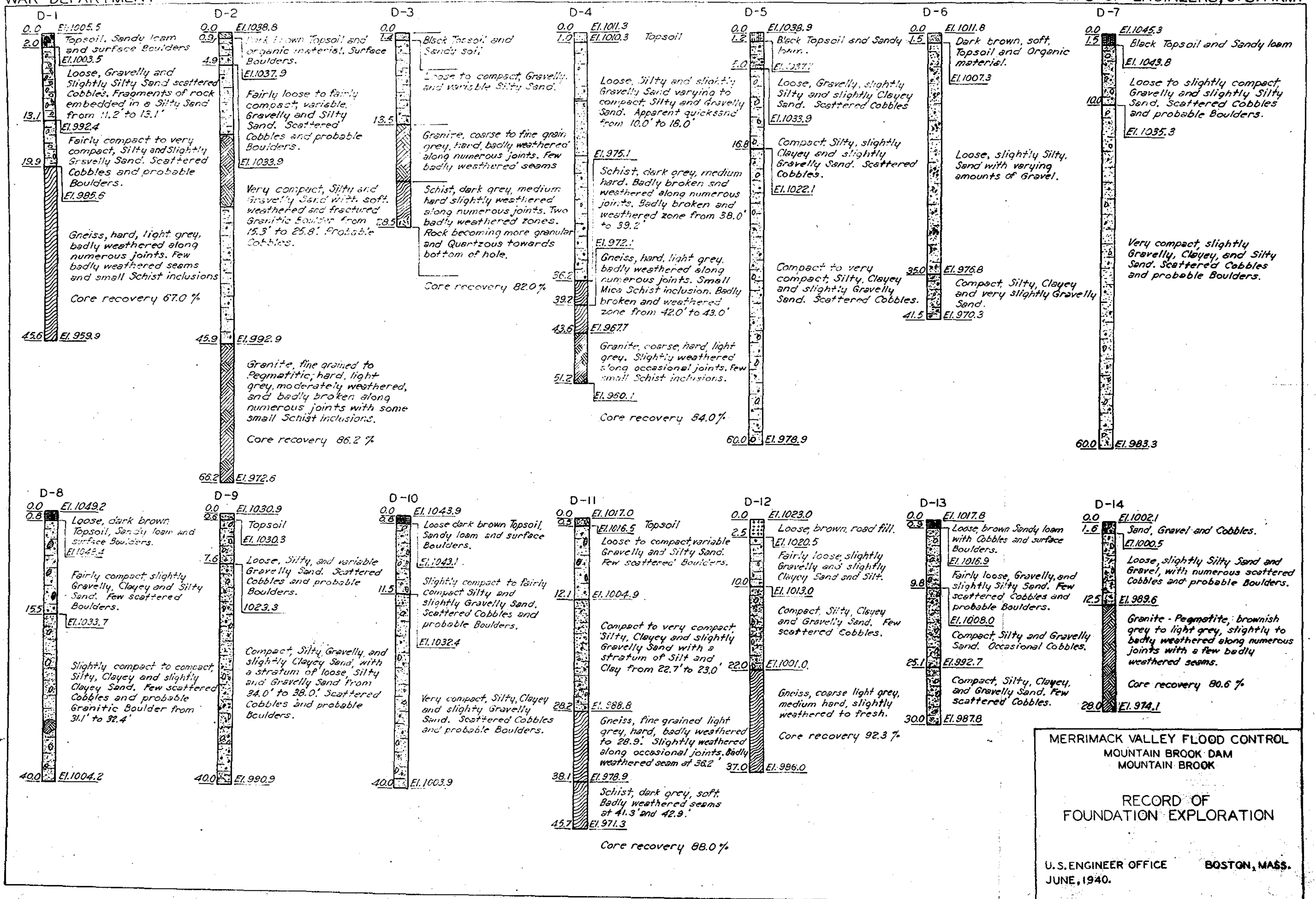
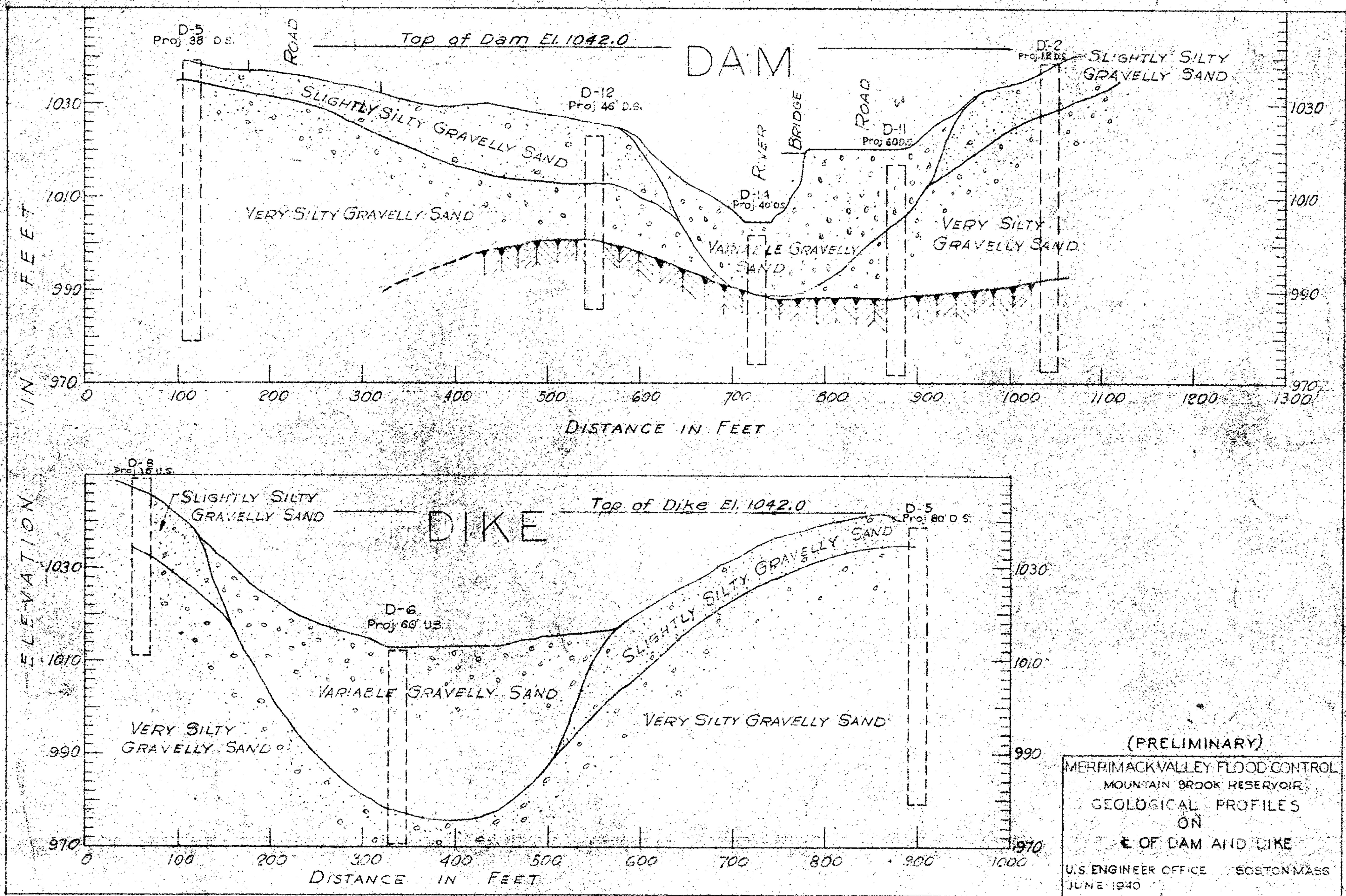


PLATE 7


DAM
Top of Dam El. 1042.0
D-5 Proj 38' D.S.
ROAD
D-12 Proj 46' D.S.
SLIGHTLY SILTY GRAVELLY SAND
VERY SILTY GRAVELLY SAND
RIVER
BRIDGE
ROAD
D-14 Proj 40' D.S.
D-11 Proj 60' D.S.
D-2 Proj 18' D.S.
SLIGHTLY SILTY GRAVELLY SAND
VARIABLE GRAVELLY SAND
VERY SILTY GRAVELLY SAND
DISTANCE IN FEET
ELEVATION IN FEET
DIKE
Top of Dike El. 1042.0
D-8 Proj 18' U.S.
SLIGHTLY SILTY GRAVELLY SAND
D-6 Proj 60' U.S.
D-5 Proj 80' D.S.
SLIGHTLY SILTY GRAVELLY SAND
VARIABLE GRAVELLY SAND
VERY SILTY GRAVELLY SAND
VERY SILTY GRAVELLY SAND
DISTANCE IN FEET
(PRELIMINARY)
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
GEOLOGICAL PROFILES
ON
℄ OF DAM AND DIKE
U.S. ENGINEER OFFICE BOSTON MASS
JUNE 1940

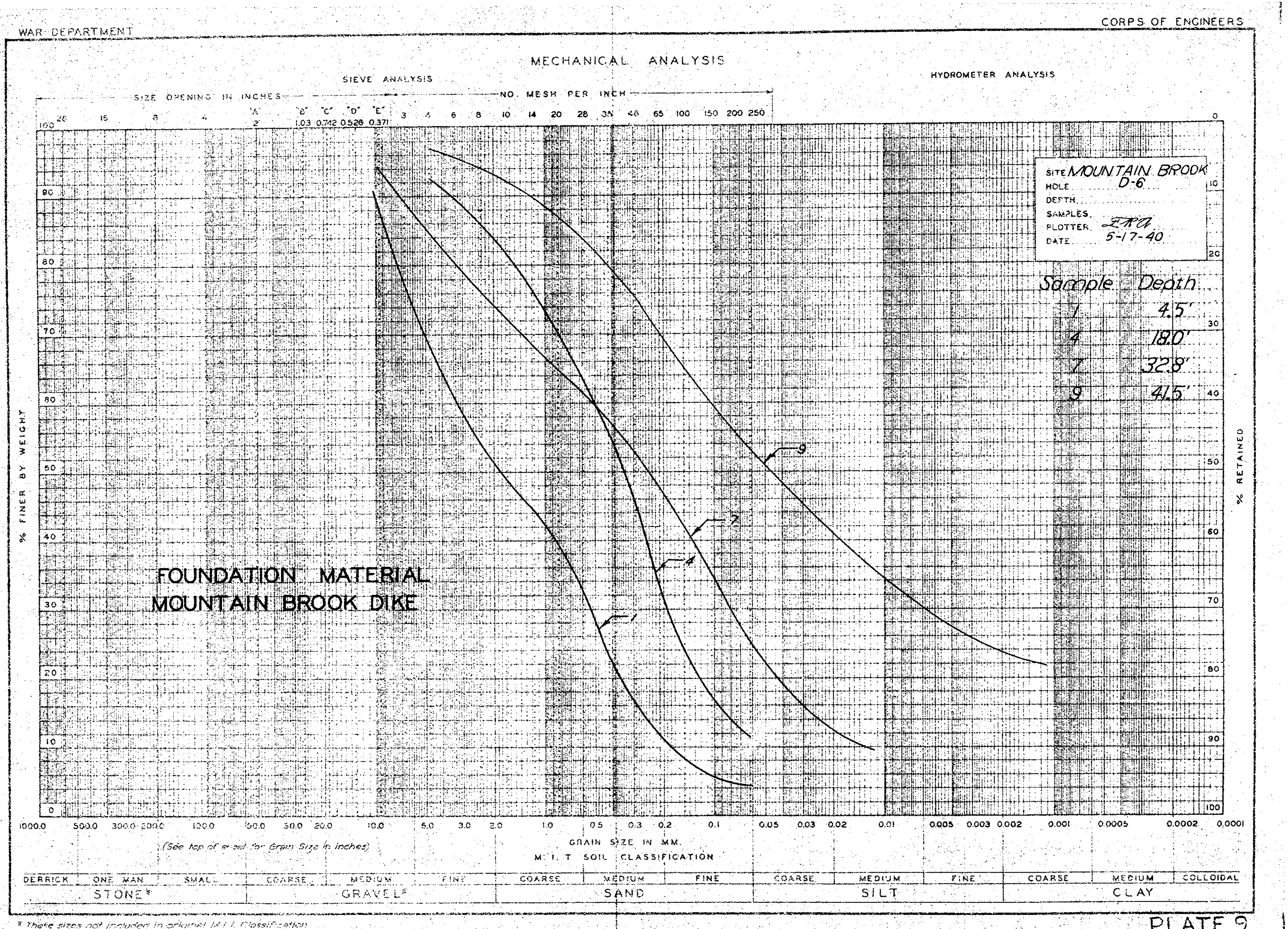
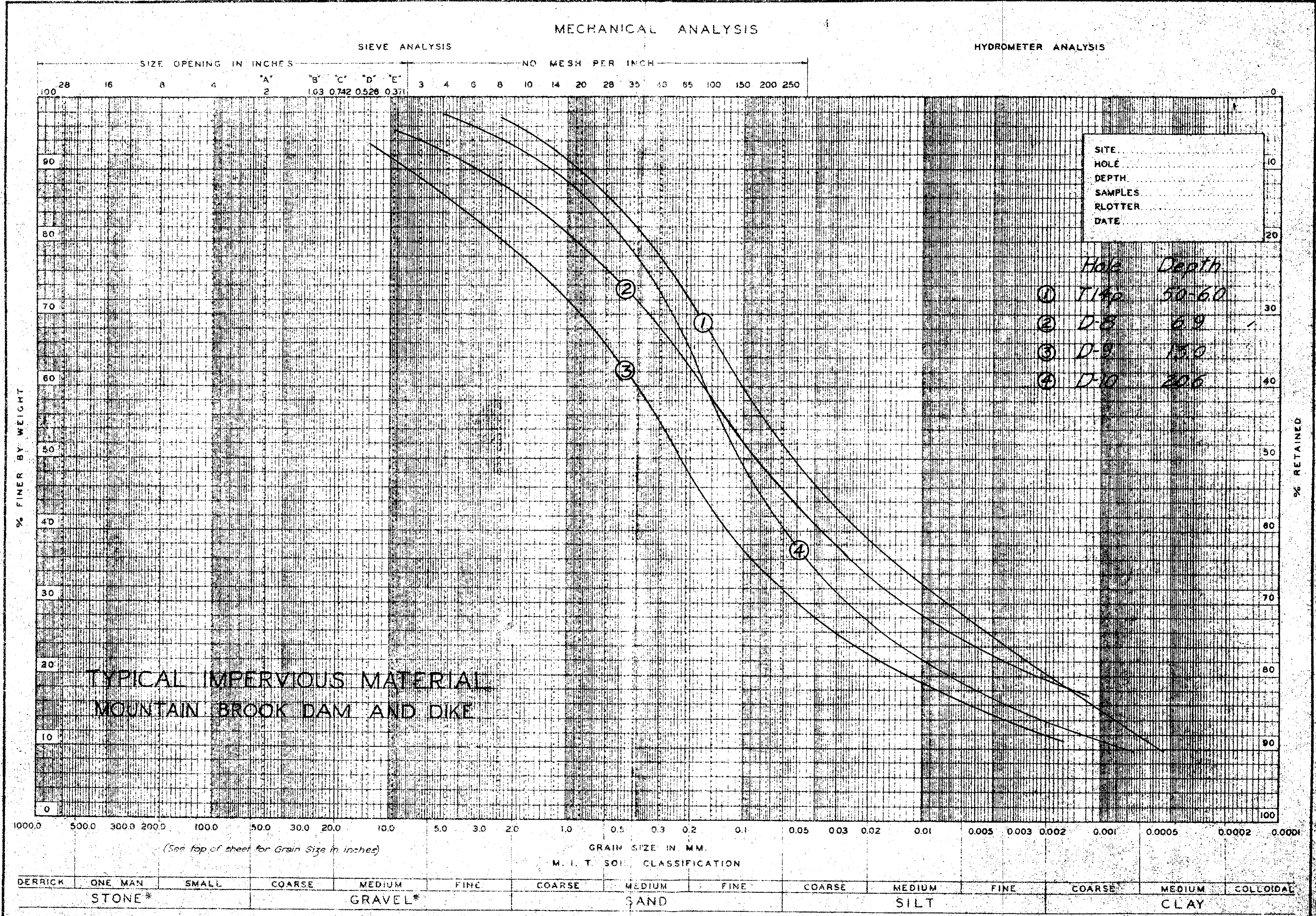

WAR DEPARTMENT
CORPS OF ENGINEERS
MECHANICAL ANALYSIS
SIEVE ANALYSIS
HYDROMETER ANALYSIS
SIZE OPENING IN INCHES
NO. MESH PER INCH
SITE MOUNTAIN BROOK
HOLE D-6
DEPTH
SAMPLES
PLOTTER
DATE 5-17-40
Sample Depth
1 4.5'
4 18.0'
7 32.8'
9 41.5'
FOUNDATION MATERIAL
MOUNTAIN BROOK DIKE
% FINER BY WEIGHT
% RETAINED
GRAIN SIZE IN MM.
(See top of sheet for Grain Size in inches)
M. I. T. SOIL CLASSIFICATION
DERRICK ONE MAN SMALL COARSE MEDIUM FINE COARSE MEDIUM FINE COARSE MEDIUM FINE COARSE MEDIUM COLLOIDAL
STONE* GRAVEL* SAND SILT CLAY
* These sizes not included in original M.I.T. Classification

PLATE 9

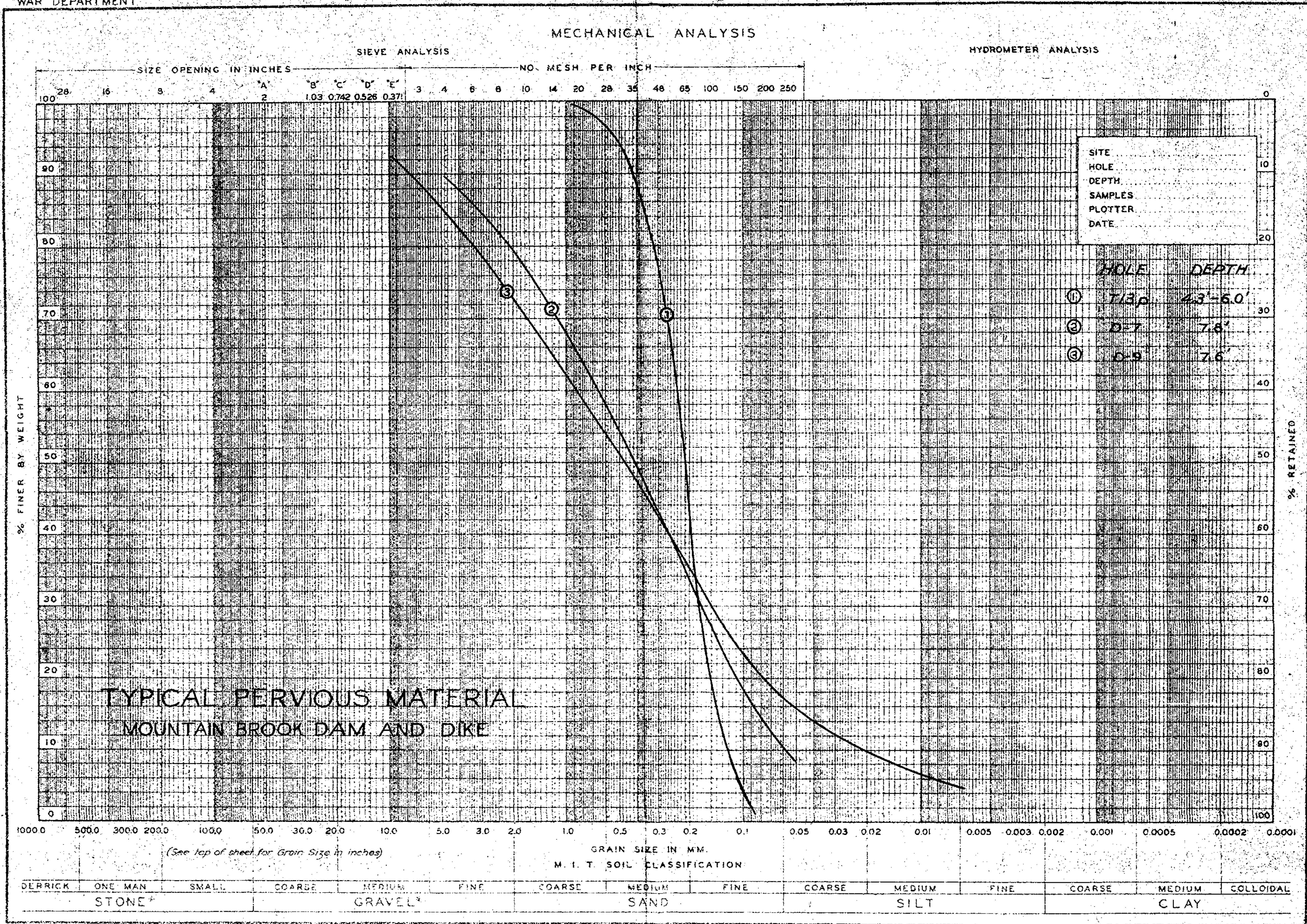


* These sizes not included in original M.I.T. Classification

PLATE 10

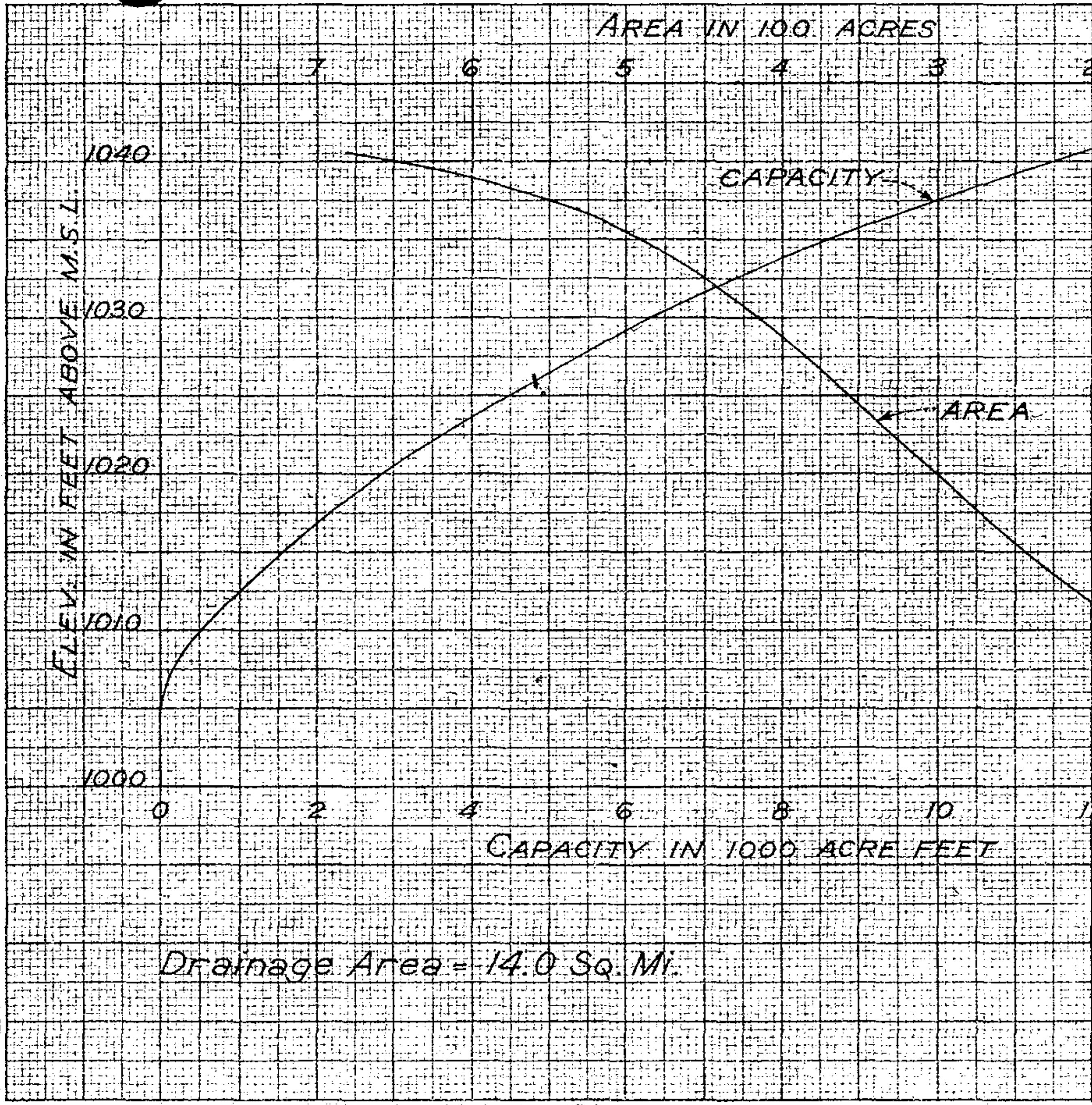
WAR DEPARTMENT

CORPS OF ENGINEERS



* These sizes not included in original M.I.T. Classification

PLATE 11



MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR

AREA AND CAPACITY CURVES

U.S. ENGINEER OFFICE BOSTON, MASS.
MAY, 1940

PLATE 12

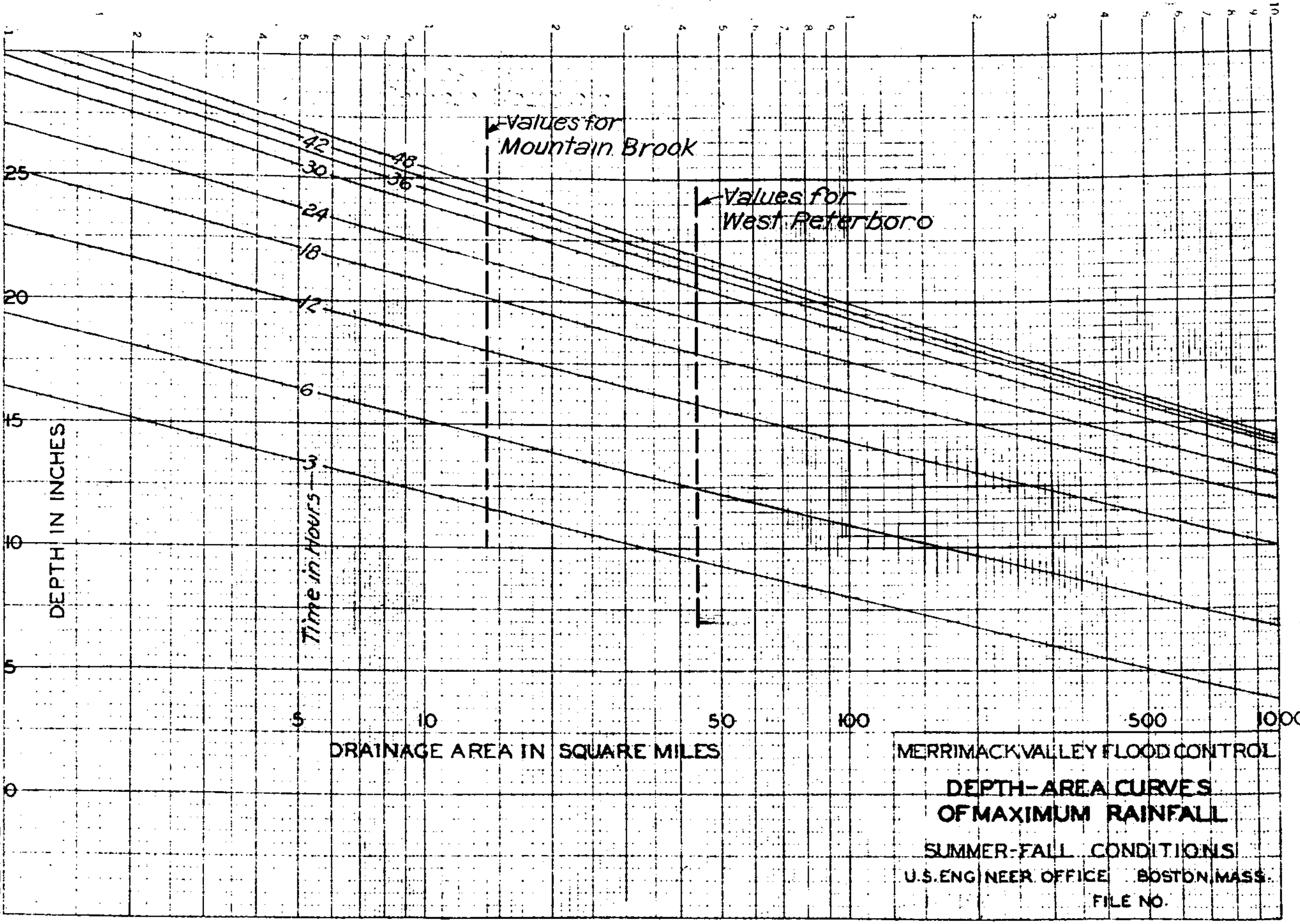

Values for Mountain Brook
Values for West Peterboro
42
48
30
36
24
18
12
6
3
Time in Hours
DEPTH IN INCHES
25
20
15
10
5
0
5
10
50
100
500
1000
DRAINAGE AREA IN SQUARE MILES
MERRIMACK VALLEY FLOOD CONTROL
DEPTH-AREA CURVES
OF MAXIMUM RAINFALL
SUMMER-FALL CONDITIONS
U.S. ENGINEER OFFICE BOSTON, MASS.
FILE NO.

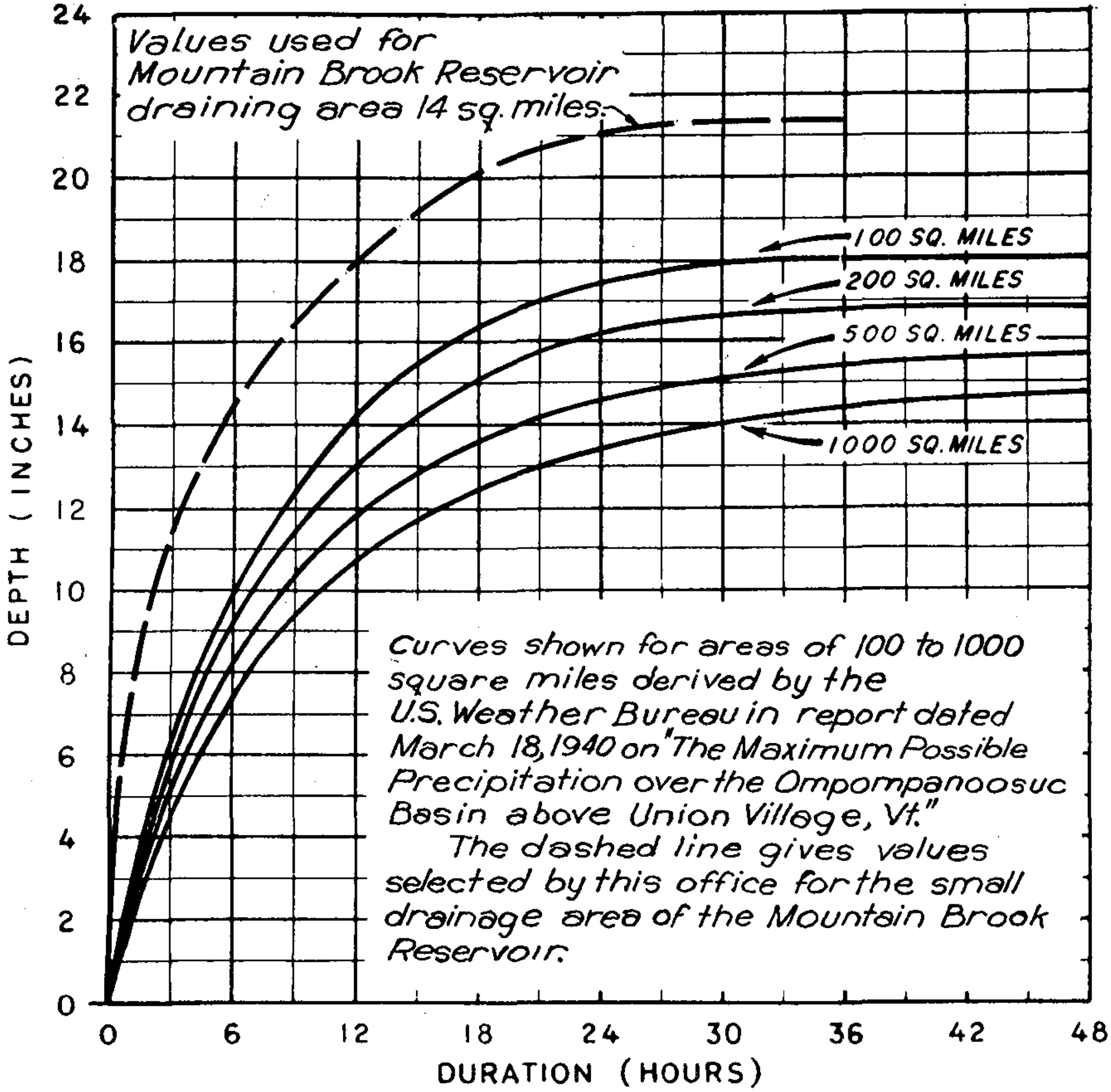
PLATE 13

U. S. DEPT. OF AGRICULTURE
WEATHER BUREAU

RIVER & FLOOD DIVISION
HYDROMETEOROLOGICAL SECTION

ENVELOPING DURATION-DEPTH CURVES OF MAXIMUM POSSIBLE RAINFALL

OVER SELECTED BASINS IN THE NEW ENGLAND REGION



MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR

RAINFALL DATA FOR SPILLWAY DESIGN

U.S. ENGINEER OFFICE BOSTON, MASS.
JUNE 1940

PLATE 14

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

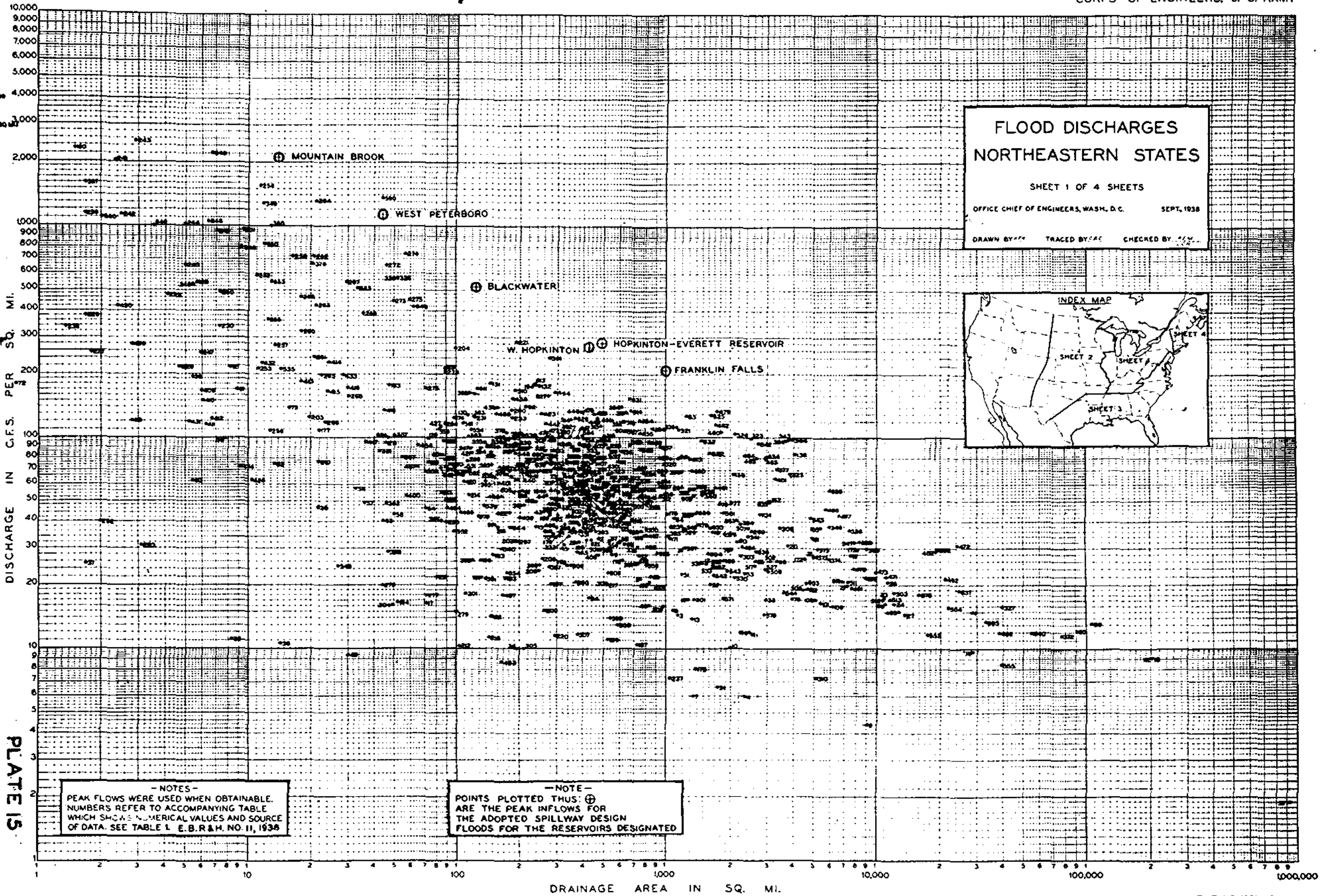
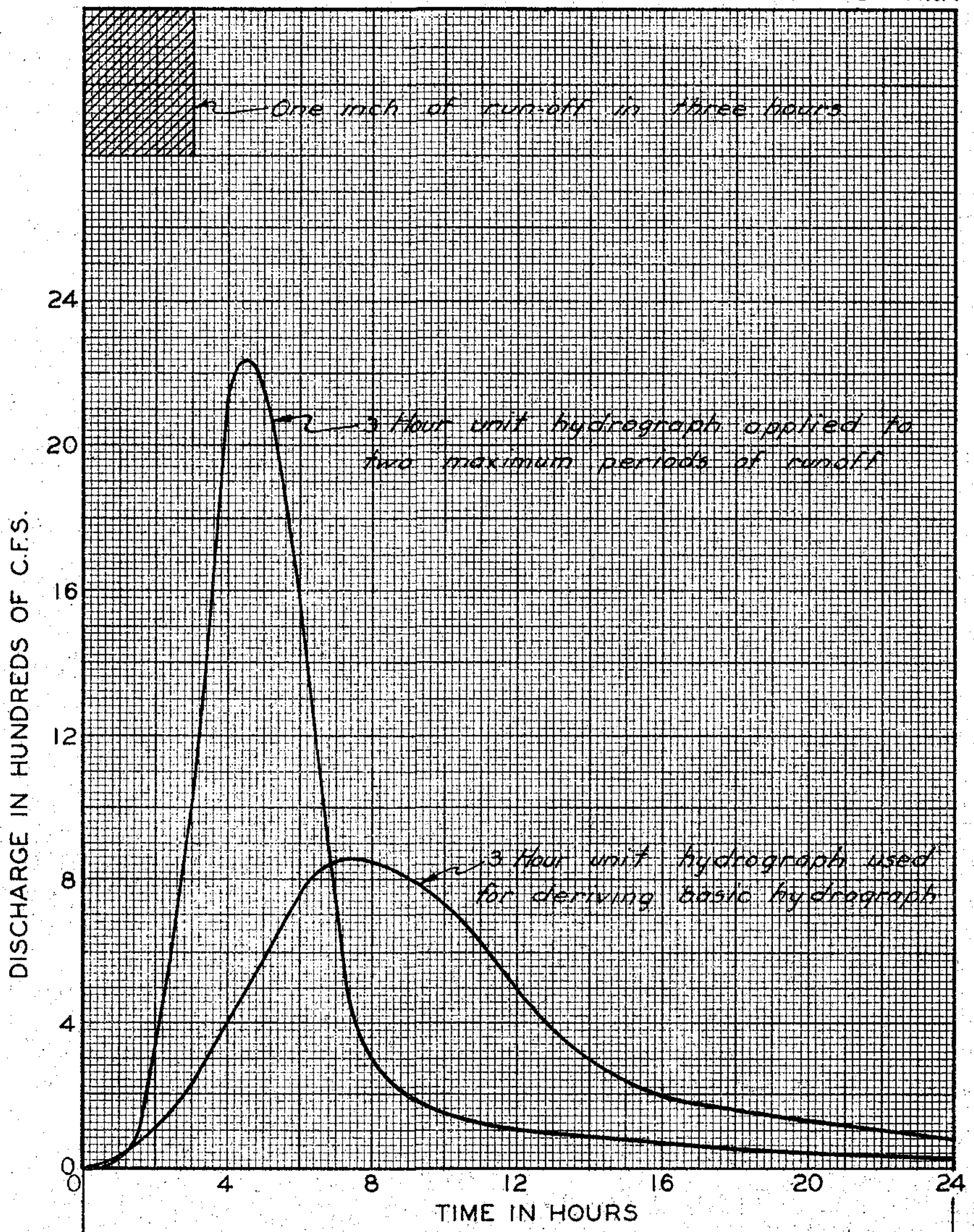


PLATE 15

FILE NO. 15814 FLAT 1

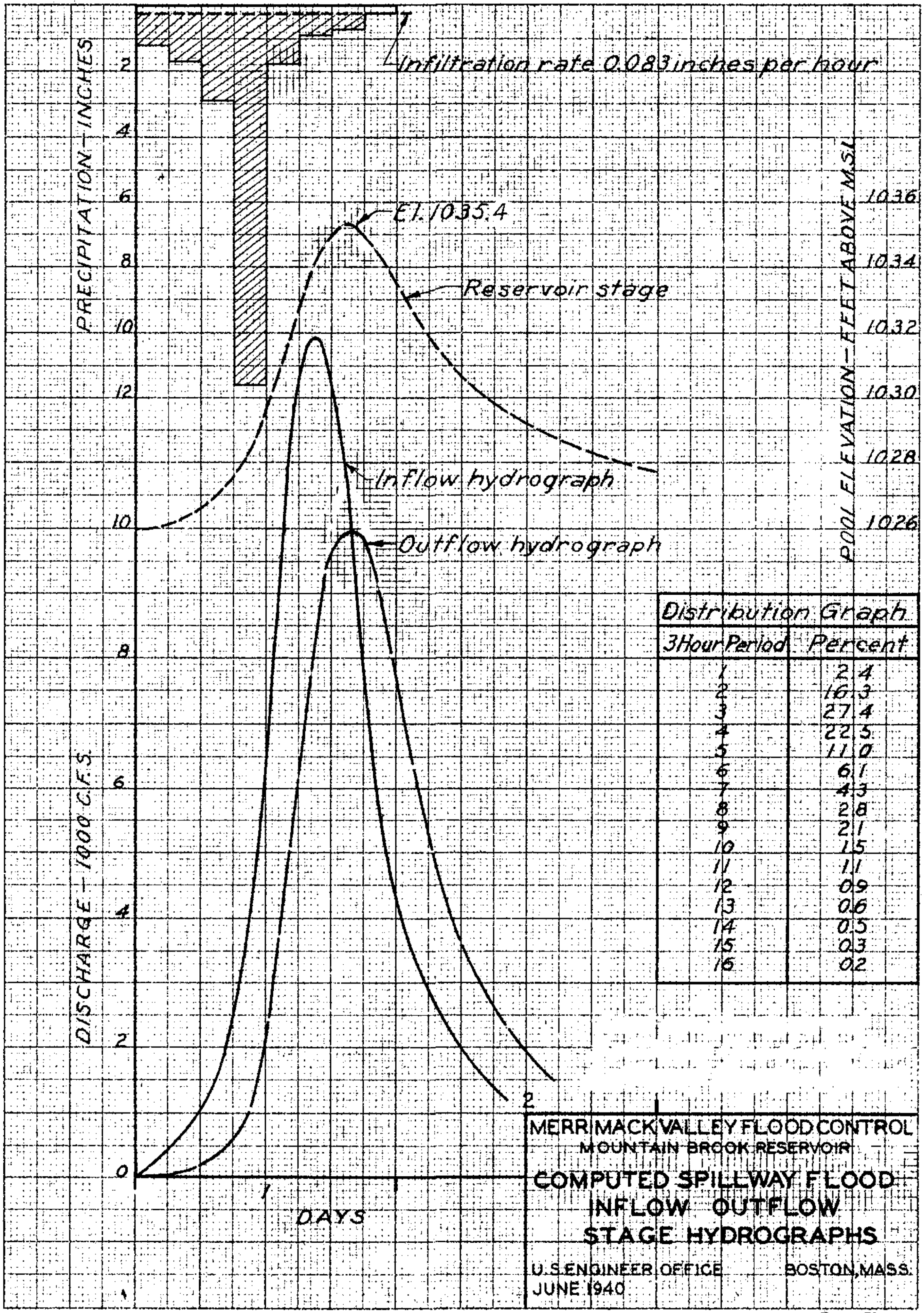


MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR

SPILLWAY DESIGN FLOOD

INFLOW-UNIT-HYDROGRAPHS

U.S. ENGINEER OFFICE BOSTON, MASS.
DEC. 1940 FILE NO.



Distribution Graph

3 Hour Period	Percent
1	2.4
2	16.3
3	27.4
4	22.5
5	11.0
6	6.1
7	4.3
8	2.8
9	2.1
10	1.5
11	1.1
12	0.9
13	0.6
14	0.5
15	0.3
16	0.2

MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR

COMPUTED SPILLWAY FLOOD INFLOW OUTFLOW STAGE HYDROGRAPHS

U.S. ENGINEER OFFICE BOSTON, MASS.
JUNE 1940

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: MOUNTAIN BROOK RESERVOIR
Computation: Computed Spillway Flood
Computed by: F.C.M.
Checked by:
Date: 5/9/40
Page:

Date		R.F. inches	Infilt. = 0.083"/hr inches	Runoff inches	Runoff dsf	Dist. Values	Distributed Runoff 1	2	3	4	5	6	7	Total dsf	Total dsf for 1/8 day
	M														
	3	1.20	0.25	0.95	357	2.4	9							9	72
	6	1.70	0.25	1.45	545	16.3	58	13						71	568
	9	2.90	0.25	2.65	996	27.4	98	89	24					211	1688
1	N	11.60	0.25	11.35	4268	22.5	80	149	162	102				493	3944
	3	1.80	0.25	1.55	583	11.0	39	123	273	696	14			1145	9160
	6	0.90	0.25	0.65	244	6.1	22	60	224	1169	95	6		1576	12608
	9	0.70	0.25	0.45	169	4.3	15	33	110	960	160	40	4	1322	10576
	M	0.25	0.25	—		2.8	10	23	61	469	131	67	28	789	6312
	3					2.1	7	15	43	260	64	55	46	490	3920
	6					1.5	5	11	28	184	36	27	38	329	2632
	9					1.1	4	8	21	120	25	15	19	212	1696
2	N					0.9	3	6	15	90	16	10	10	150	1200
	3					0.6	2	5	11	64	12	7	7	108	864
	6					0.5	2	3	9	47	9	5	5	80	640
	9					0.3	1	3	6	38	6	4	4	62	496
	M					0.2	1	2	5	26	5	3	3	45	360
	3							1	3	21	3	2	2	31	248
	6								2	13	3	1	2	21	168
	9									9	2	1	1	13	104
3	N										1	1	1	3	24
	3											—	1	1	8
													—		
		21.05		19.05	7162	100.0								7161	57288

PLATE 17

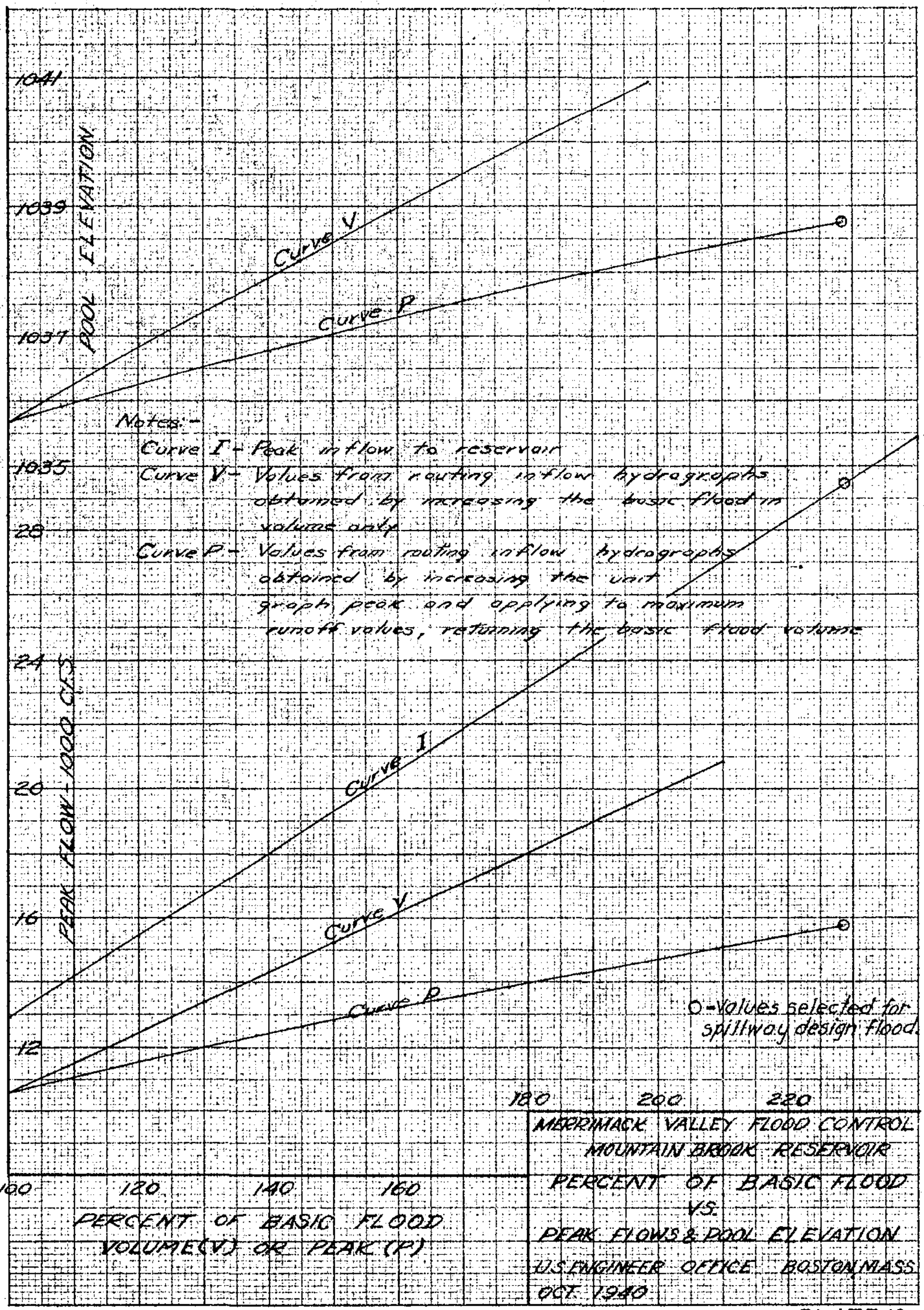
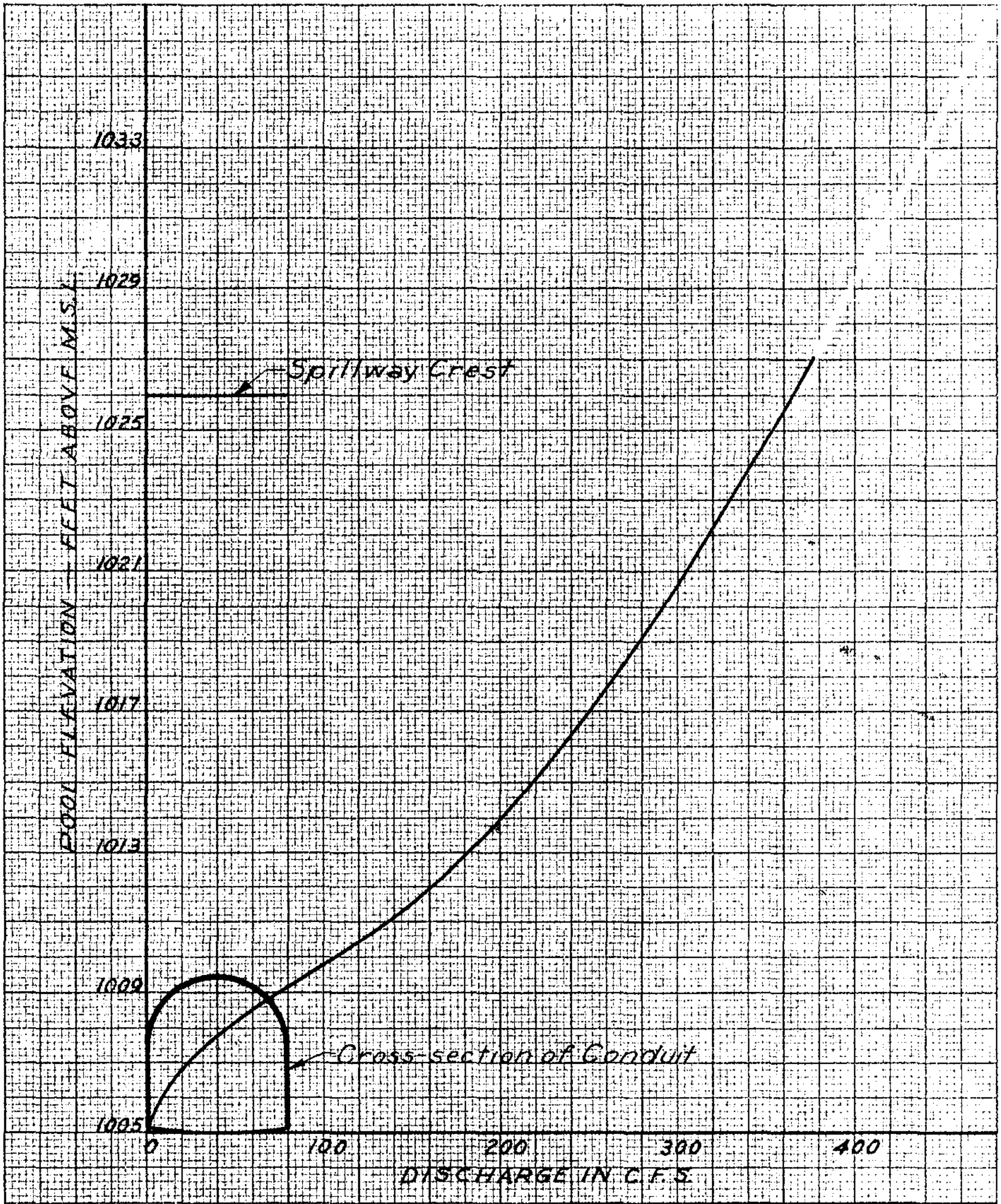

1041
1039
1037
1035
POOL ELEVATION
Curve V
Curve P
Notes:-
Curve I - Peak inflow to reservoir
Curve V - Values from routing inflow hydrographs obtained by increasing the basic flood in volume only
Curve P - Values from routing inflow hydrographs obtained by increasing the unit graph peak and applying to maximum runoff values, retaining the basic flood volume
28
24
20
16
12
PEAK FLOW-1000 C.F.S.
Curve I
Curve V
Curve P
O-Values selected for spillway design flood.
100
120
140
160
180
200
220
PERCENT OF BASIC FLOOD VOLUME(V) OR PEAK (P)
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
PERCENT OF BASIC FLOOD VS. PEAK FLOWS & POOL ELEVATION
U.S. ENGINEER OFFICE BOSTON, MASS.
OCT. 1940

PLATE 19

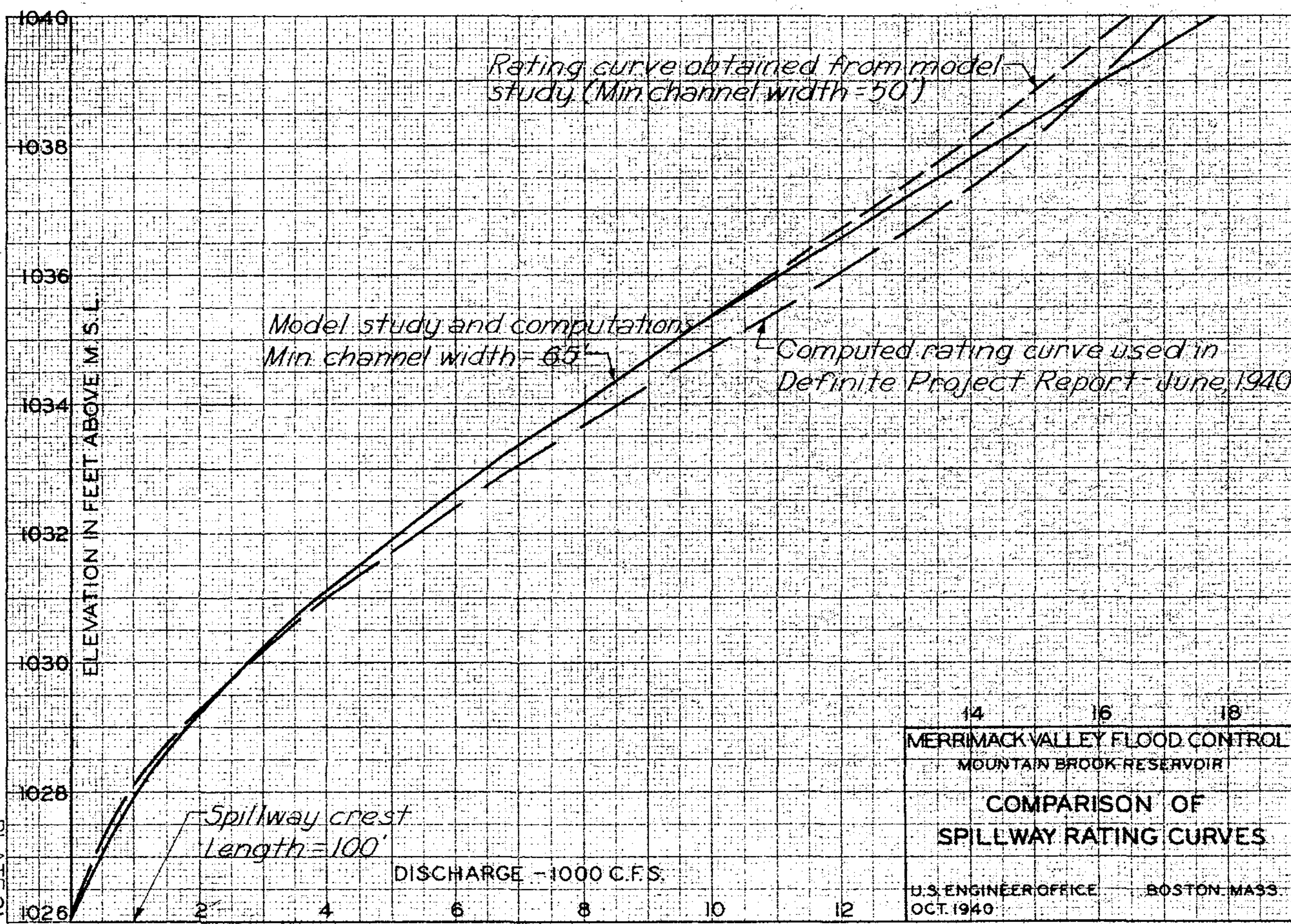


MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR

OUTLET RATING CURVE

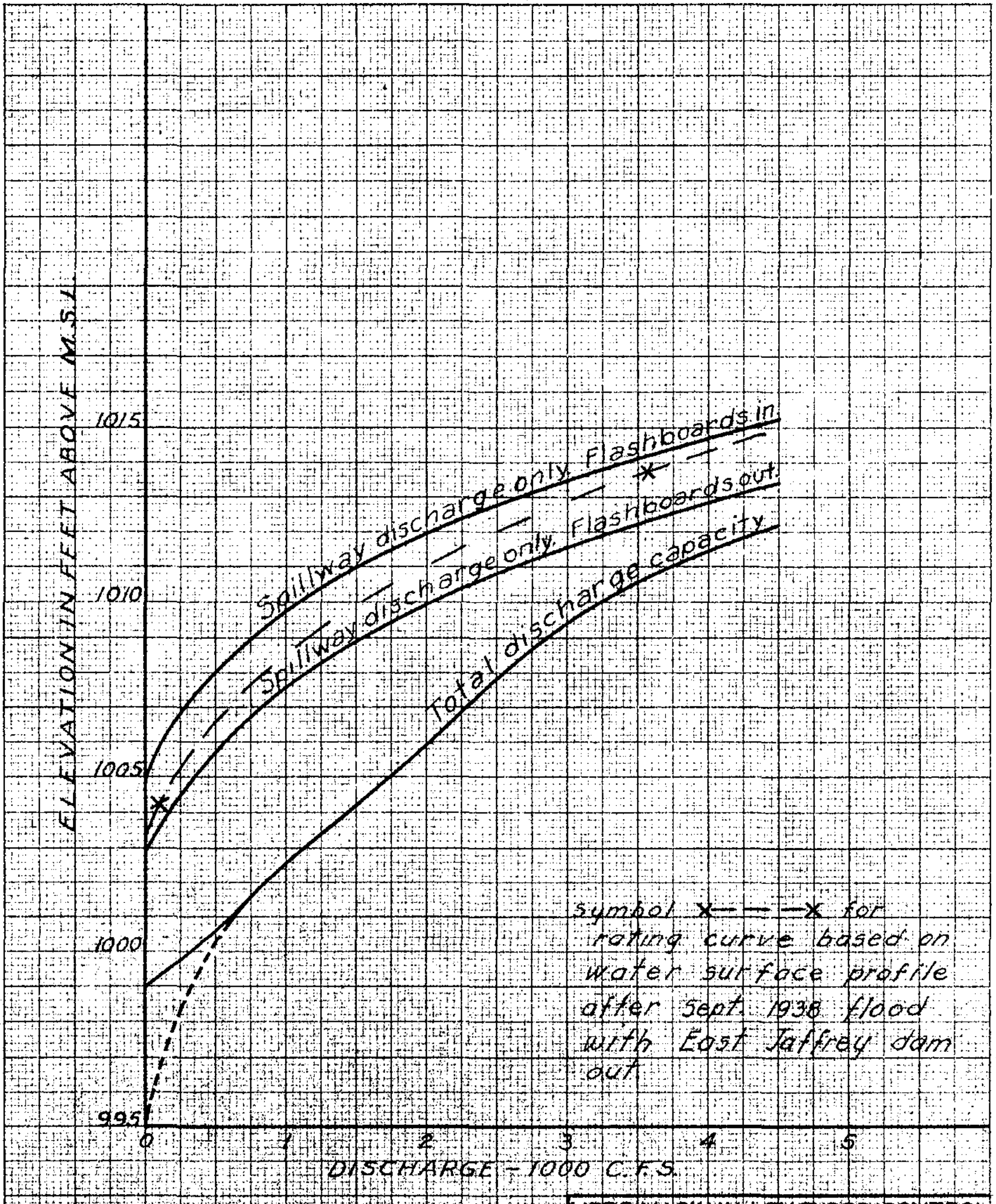
U.S. ENGINEER OFFICE BOSTON, MASS.
JUNE 1940

PLATE 20



Rating curve obtained from model study (Min channel width = 50')
Model study and computations Min. channel width = 65'
Computed rating curve used in Definite Project Report - June, 1940
Spillway crest Length = 100'
ELEVATION IN FEET ABOVE M.S.L.
DISCHARGE - 1000 C.F.S.
1026
1028
1030
1032
1034
1036
1038
1040
2
4
6
8
10
12
14
16
18
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
COMPARISON OF SPILLWAY RATING CURVES
U.S. ENGINEER OFFICE BOSTON, MASS.
OCT. 1940

PLATE 21



MERRIMACK VALLEY FLOOD CONTROL

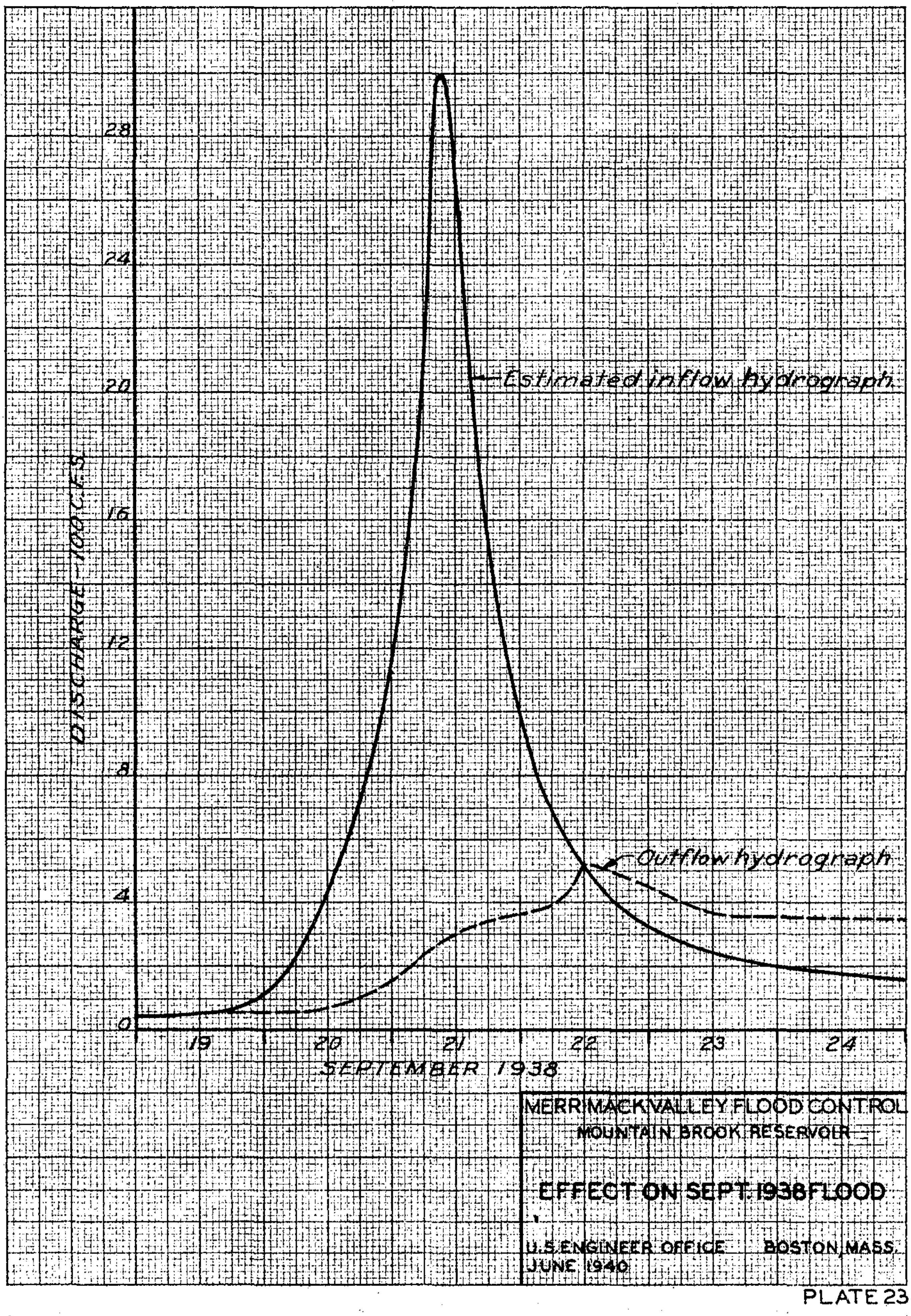
MOUNTAIN BROOK RESERVOIR

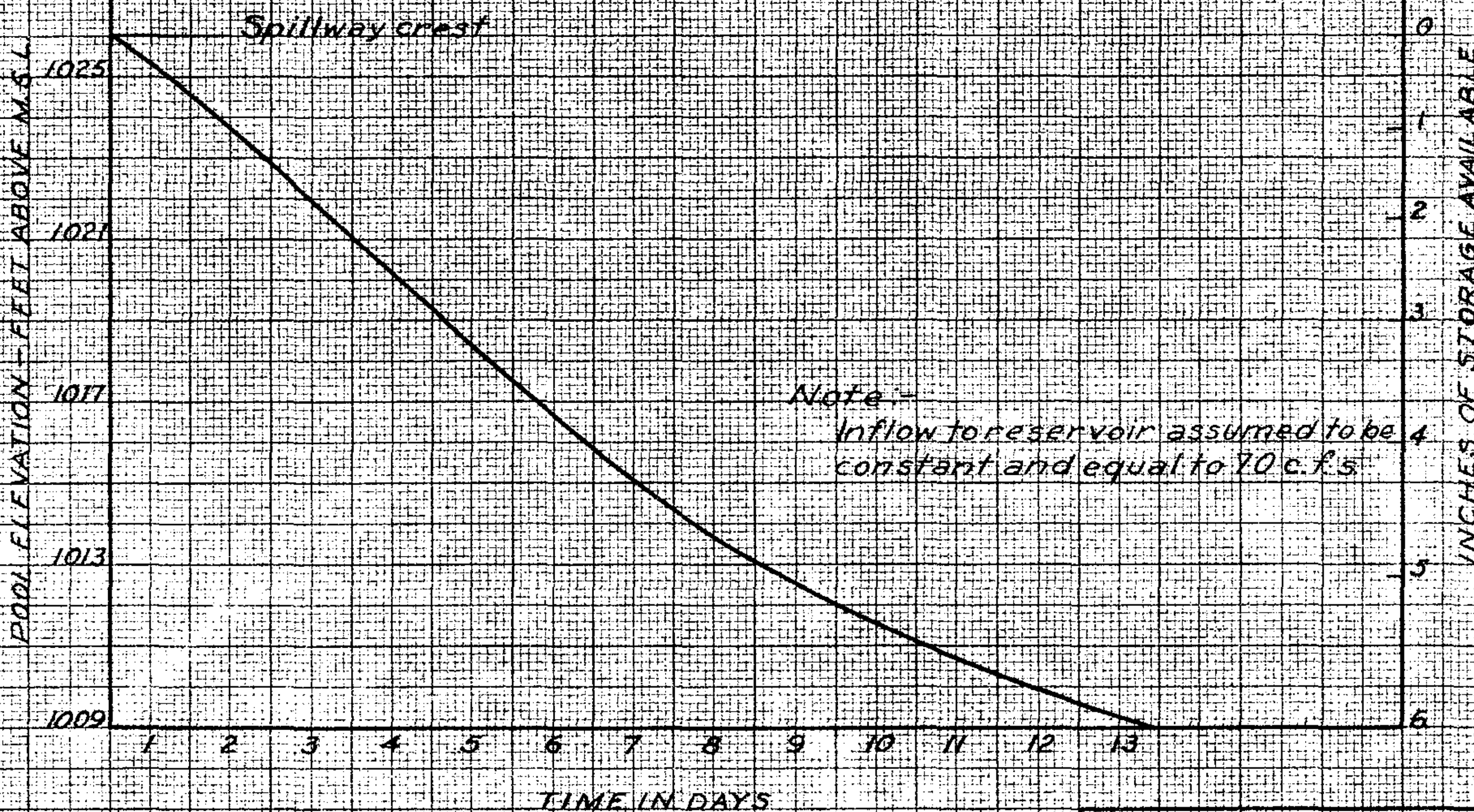
COMPUTED TAIL WATER RATING CURVE

BASED ON EAST JAFFREY DAM

U.S. ENGINEER OFFICE BOSTON MASS.

JUNE 1940


DISCHARGE - 100 C.F.S.
28
24
20
16
12
8
4
0
19
20
21
22
23
24
SEPTEMBER 1938
Estimated inflow hydrograph
Outflow hydrograph
MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR
EFFECT ON SEPT. 1938 FLOOD
U.S. ENGINEER OFFICE BOSTON, MASS.
JUNE 1940



MERRMACK VALLEY FLOOD CONTROL

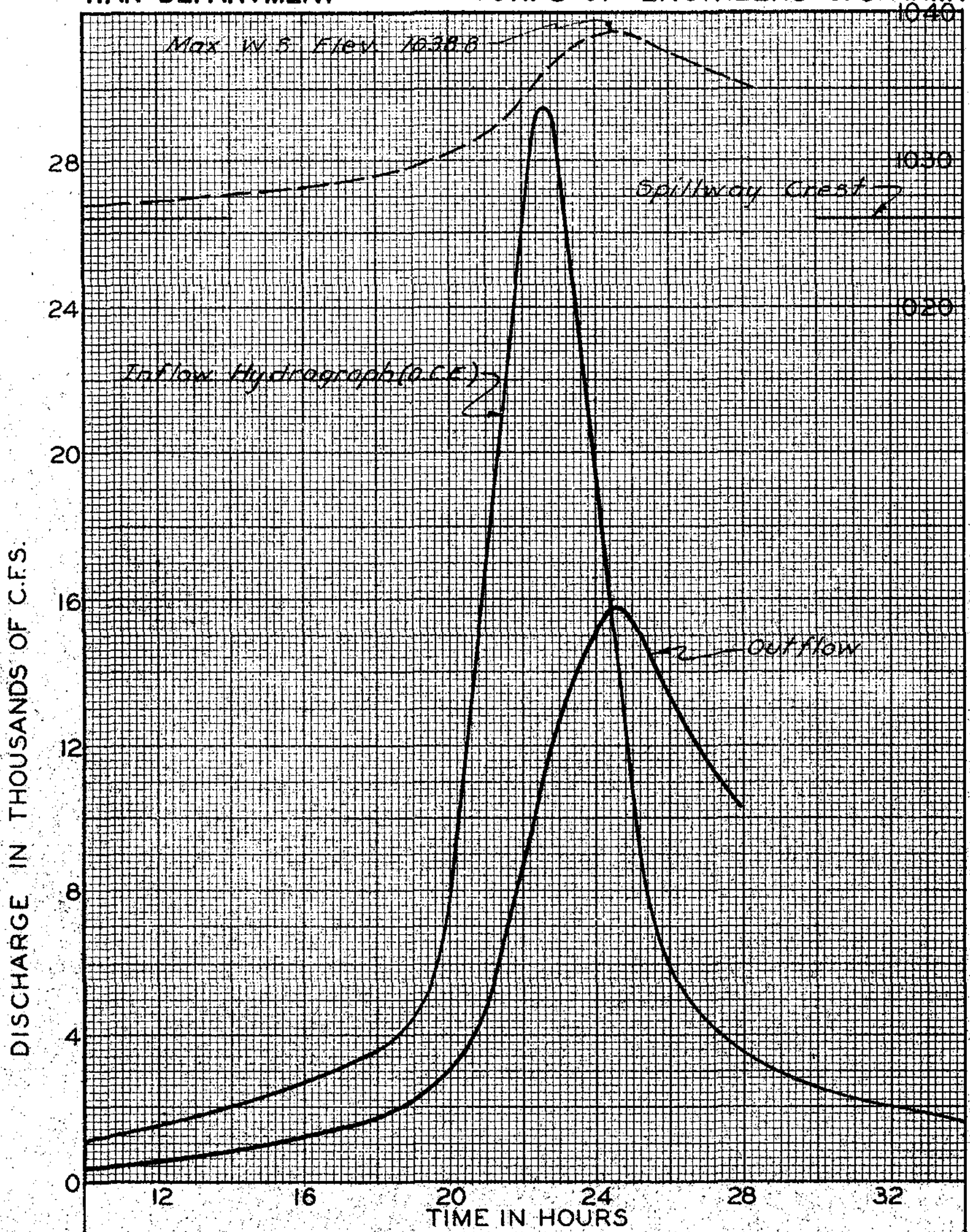
MOUNTAIN BROOK RESERVOIR

TIME TO EMPTY RESERVOIR

U.S. ENGINEER OFFICE BOSTON, MASS.

JUNE 1940

WAR DEPARTMENT CORPS OF ENGINEERS U.S. ARMY



MERRIMACK VALLEY FLOOD CONTROL
MOUNTAIN BROOK RESERVOIR

SPILLWAY DESIGN FLOOD
INFLOW - OUTFLOW
STAGE - HYDROGRAPHS

U.S. ENGINEER OFFICE BOSTON, MASS.
DEC. 1940. FILE NO.

PLATE 25

6 November 1945

MODIFICATION TO APPROVED
DEFINITE PROJECT REPORT
FOR
MOUNTAIN BROOK RESERVOIR
MOUNTAIN BROOK, NEW HAMPSHIRE

- DESIGN MODIFICATIONS -

(Appendix G to Definite Project Report dated 1 June 1940 (Revised 16 December 1940))

1. Introduction.- This supplemental report is prepared to submit for approval in accordance with Order and Regulations, paragraph 740.04e, deviations in the final design of Mountain Brook Dam from the requirements of the approved definite project report, revised 16 December 1940. The scope of this supplemental report is limited to a discussion of the these deviations. Detailed discussion and description of the design of Mountain Brook Dam is contained in the Design Analysis, which contains all pertinent plates, graphs and schedules pertaining to hydrological, meterological, geological and design features of the dam. Complete drawings, as prepared for contract work, are included in Appendix A of the Design Analysis.

2. Capacity of Reservoir.- The capacity of the reservoir as stated in the revised definite project report is 4800 acre-feet at a spillway lip elevation of 1026. This elevation was determined from U.S.G.S. Quadrangle Sheet "Monadnock N.H." using several surveyed cross-sections of the reservoir to determine the intermediate elevations between the 20-foot contours of the Quadrangle Sheet.

An aerial topographic survey of the reservoir area was made early in 1941, and the capacity of the reservoir at Elevation 1026 as determined from this survey is 3400 acre-feet. The aerial survey was checked by a field survey, with particular attention being given to the central portion of the reservoir where the valley slopes are relatively flat and which portion comprises the greater part of the reservoir storage capacity. A new area-capacity curve was plotted on the basis of the aerial survey with elevations modified by field survey results. This now area-capacity curve indicated a capacity of 4900 acre-feet at Elevation 1026.

The capacity of the reservoir at Elevation 1027, based upon the modified aerial survey is 5,300 acre feet. This elevation is selected as the final spillway elevation to assure that the desired storage capacity of 4800 acre-feet is available and that 400 acre-feet of conservation storage below the outlet works weir elevation of 1009.5 can be utilized, if desired, to flood the swamp land in the vicinity of the dam.

3. Revised Spillway Design Flood.- Subsequent to the submission of the revised definite project report, spillway design storms have been revised in accordance with the latest information, regarding the intensity and distribution of rainfall in spillway design storms, that has been received by the Office of the Chief of Engineers, from the Hydrometerological Section of the Weather Bureau and has been transmitted to this office. In accordance with the recommendations made at a conference with the Board of Consultants and representatives of the New England Division and the Office of the Chief of Engineers, held at this office December 14 and 15, 1944, the spillway design flood was reviewed in consideration of this new data, with the resultant determination that the surcharge over the spillway crest is 0.8 foot lower than originally computed. Further study was also made on unit hydrographs that might be applicable to this site. The review of this data is discussed in detail in Section III of the Design Analysis for Mountain Brook and the following curves are shown on plates contained therein.

Area and Capacity Curves	Plate III-1
Discharge Curves	Plate III-3
Curves of Limiting Rainfall	Plate III-4
Spillway Design Flood	Plate III-6

4. Freeboard.- The determination that the maximum surcharge over the spillway crest is 0.8 foot lower resulted in the converse determination that the freeboard is 4.0 feet in height in lieu of the 3.2 feet noted in the revised definite project report. The 4.0 foot freeboard is the minimum considered acceptable by some of the members of the Board of Consultants and is approximately equal to the required 4.2-foot freeboard determined by the procedure set forth in Engineer Bulletin, R & H No. 9, 1938. It is believed that this freeboard is reasonable and adequate in view of the extremely short duration of the maximum stage of peaked inflow.

5. Elevation of Top of Dam.- The elevation of the top of the dam and dike is raised from elevation 1042, as reported in the approved definite project report, to elevation 1043, to correspond with the one-foot increase in height of spillway crest. The computed elevation is 1043.2 derived by the summation of the elevation of the spillway crest, the maximum surcharge over the spillway crest and the required freeboard.

6. Dam and Dike Embankment.- The sections of the dam and dike embankments have been slightly modified. The top width of the dam has been increased to provide a roadway width of 24 feet on an embankment width of 42 feet in lieu of a roadway width of 22 feet on an embankment width of 32 feet. The crown elevation of the road has been raised from 1042.33 to 1043.15, an increase of 0.82 feet. To obtain proper drainage and protection from frost heaving, a gravelly sand sub-base course 18 inches thick, has been provided under the road pavement and sand and gravel base course. The bridge over the spillway has been increased from a

width of 26 feet between curbs to a width of 28 feet. The modified design of the road and bridge conforms with the New Hampshire Highway Department Standards and the U. S. Bureau of Public Roads recommendation for roads carrying the same normal traffic densities as U. S. Route No. 202.

7. The upstream slope of the dam and dike embankments has been changed from a uniform slope of 1 to 4 to dished slopes of 1 on 2.5 and 1 on 3. Protection from erosion has been changed to 15 inches of riprap on 15 inches of sand and gravel in lieu of 6 inches of seeded topsoil. This modification has been made pursuant to the suggestions of Mr. W. H. McAlpine, Special Assistant to the Chief of Engineers.

8. The seeded topsoil on the downstream slopes of the dam and dike embankments have been increased from six inches to nine inches in thickness following a decision made by the Board of Consultants. The downstream slopes of the dam have been changed from dished slopes of 1 on 2.5 and 1 on 3 to dished slopes of 1 on 2.25 and 1 on 3. Downstream slopes of the dike have not been changed.

9. The impervious and random fill sections of the dam and dike embankments have been modified to utilize the available quantities of such materials as indicated by further subsurface explorations.

10. Spillway.- Open joint pipe drains laid longitudinally with the spillway and perforated pipe drains laid transversely to the centerline have been provided under the spillway slab in lieu of weep holes to relieve hydrostatic pressure in the filter sub-base. This design is the result of suggestions made by the Board of Consultants.

11. The protection at the end of the spillway stilling basin has been changed from two feet of derrick stone on twelve inches of gravel to three feet of dumped rock riprap on twelve inches of screened gravel over six inches of gravelly sand, with the riprap extended to protect the ends of the stilling basin walls. This modification was decided upon at the Consultants Conference.

12. Outlet Works.- The length of the conduit monoliths has been changed from 33'-3" to approximately 20 feet in length. The protection at the end of the conduit stilling basin has been changed from 15 inches of riprap placed on 6 inches of gravel to 2 feet of dumped riprap on 12 inches of screened gravel over 6 inches of sand and gravel. These modifications have been made in accordance with decisions made at the Consultants Conference.

13. Relocated Road.- An existing road serving dwellings north of the spillway and west of U. S. Highway Route No. 202 is relocated along the spillway embankment to provide continued access to the houses. This road is to be surfaced with bituminous surface treated sand and gravel.

14. Estimated Cost.- The estimated cost carried in the revised definite project report is as follows:

Dam Spillway and Outlets	$290,000
Land and Rights of Way	40,000
Relocation	40,000
	$370,000

Since the revised definite project report was approved the cost of the project has increased for the following reasons: (1) contemplated costs for severances and water rights not previously included in the cost of lands and improvements; (2) revisions made in the design of the dam and appurtenant structures; (3) increased costs of construction and materials; and (4) increase in the District and Division Office overhead charges. The construction cost of the proposed project, including land acquisition, is shown in the detailed estimate below. The total initial cost of the project, including design charges is $680,200 = ($638,200 + $42,000).

ESTIMATE OF COST
CONSTRUCTION OF MOUNTAIN BROOK DAM

Item	Designation	Quantity	Unit	Unit Cost	Total Cost
1	Temporary Roads	1	Job	L.S.	$ 7,000.
2	Removal of Existing Structures	1	Job	L.S.	2,500.
3	Clearing	1	Job	L.S.	5,000.
4	Diversion and Care of Brook	1	Job	L.S.	6,500.
5	Stripping	40,000	Cu.Yd.	0.55	22,000.
6	Common Excavation	82,000	Cu.Yd.	0.40	32,800.
7	Excavation & Haul, Borrow Area A	115,500	Cu.Yd.	0.50	57,750.
8	Excavation & Haul, Borrow Area B	26,000	Cu.Yd.	0.55	14,300.
9	Rock Excavation	1,000	Cu.Yd.	4.50	4,500.
10	Road Scarification	1,400	Sq.Yd.	0.15	210.
11	Grout Pipes	13	Each	15.00	195.
12	Drilling Holes for Pressure Grouting	260	Lin.Ft.	2.50	650.

New 2/46

Item	Designation	Quantity	Unit	Unit Cost	Total Cost
13	Pressure Grouting	100	Cu.Ft.	4.00	$ 400.
14	Sand and Gravel	7,500	Cu.Yd.	1.60	12,000.
15	Screened Gravel	1,000	Cu.Yd.	2.00	2,000.
16	Compacted Fill	170,000	Cu.Yd.	0.15	25,500.
17	Tamped Fill	3,400	Cu.Yd.	0.50	1,700.
18	Additional Rolling	1,500	100 Sq.Ft.	0.25	375.
19	Riprap	6,900	Cu.Yd.	4.00	27,600.
20	Top Soiling and Seeding 4-inches Deep	78	1000 Sq.Ft.	23.00	1,794.
21	Top Soiling and Seeding 9-inches Deep	236	1000 Sq. Ft.	36.00	8,496.
22	Concrete 3-inch Aggregate	3,100	Cu.Yd.	14.00	43,400.
23	Concrete $1\frac{1}{2}$ inch Aggregate	3,600	Cu.Yd.	20.00	72,000.
24	Furnishing Cement	11,000	Bbls.	2.90	31,900.
25	Steel Reinforcement	404,000	Lb.	0.08	32,320.
26	Copper Water Stops	650	Lb.	0.60	390.
27	Gage House	1	Job	L.S.	700.
28	Miscellaneous Metal	1	Job	L.S.	1,300.
29	Stop Logs	1	Job	L.S.	100.
30	Vertical Joint Protection	500	Lin.Ft.	0.75	375.
31	Cement-Asbestos Pipe for Weep Holes	96	Lin.Ft.	1.00	96.
32	Spillway Sub Drain	1	Job	L.S.	1,600.
33	Walks and Steps	1	Job	L.S.	500.
34	Drainage System	1	Job	L.S.	700.

11574

New 2/46

Increase due to OCE changes

Rip rap - $7,000

Log boom - $3,000

Steel Piling - 10,000

Fill around spillway wall sets - 10,000

$30,000

25% 7500

37,500

Say 40,000

Note

This est. was forwarded to the OCE with the plans and therefore does not include any cost of the changes required by the OCE.

This is the latest reported estimate to the OCE.

[illegible]

3 July 46

Item	Designation	Quantity	Unit	Unit Cost	Total Cost
35	Sand and Gravel Road Courses	2,400	Cu.Yds.	1.80	$ 4,320.
36	Bituminous Surface Treatment	3,900	Gal.	0.25	975.
37	Cover Aggregate	47	Ton	3.00	141.
38	Road Mix Pavement	830	Ton	5.00	4,150.
39	Cut-Back Asphalt for Road-Mix Pavement	9,900	Gal.	0.18	1,782.
40	Plant Mix Pavement for Bridge	30	Ton	12.00	360.
41	Granite Curb	1	Job	L.S.	700.
42	Bridge Spillway and Outlet Works Guard Rails	1	Job	L.S.	2,300.
43	Highway Guard Rail	2,400	Lin.Ft.	2.50	6,000.
44	Wheel Stop	14	Each	30.00	420.
	Total - Items 1 to 44, inclusive......................				$439,799.

****

Total Items 1 to 44 inclusive	$439,799		
Contingencies 10%	43,981		
		$483,780	
District and Division Overhead 6%		29,020	
Inspection, Supervision, and Engineering during Construction		50,000	
District and Division Office Overhead on Hired Labor Operation of 50,000 at 12%		6,000	$568,800.
Land and Relocations:			
Land and Improvements	$ 39,500		
Relocations	17,000	56,500	
Acquisition Expenses 15%-(56,500)		8,500	
Government Overhead			
12% of 8500	1,010		
6% of 56,500	3,390		
		4,400	
			69,400.
TOTAL PROJECT COST..................			$638,200.

Agrees with latest Dos Analysis estimate

See breakdown of funding by Mr. Allen and next page.

N&W 2/46

Note

OCE tel stated that the project could not be let to lowest bidder if the cost exceeded 25% of the reported project cost of $560,000

As the low bid plus OH etc was greater — then Mr Allen sent a letter to OCE requesting add'l funds as follows:
on 5 Apr 46

Real Estate and Utilities	79,400
Plans, Specs etc	45,000
Insp. of Const	79,000
Low bid	489,094.50
Cont - 10% of $489,094.50	49,905.50
Dis & Div OH 6% of $538,000	32,280.00
Total Funds req'd	$773,680.00
Present allotment	563,000.00

add'l funds req'd $210,000

773,680
79,000
694,680

15. Carrying Charges.- The total annual carrying charge for the reservoir, based upon interest on the investment, on amortization of structures and equipment, and on operation and maintenance, is $29,811 as summarized in the following table.

ANNUAL COSTS AND CARRYING CHARGES

FEDERAL INVESTMENT

1. Total First Cost:

a. Structures with 50 year life......................$638,200.

2. Interest During Construction:
(3% for one-half construction period)..............$ 9,573.

3. Total Investment:

a. Structures with 50 year life......................$647,773.
b. Engineering Expenses.................................42,000.
c. Total Federal Investment..........................$689,773.

ANNUAL FEDERAL CARRYING CHARGES

1. Interest on Investment at 3% ....$ 20,693.

2. Amortization:
a. Structures with 50 year life (0.887%) ....$ 6,118.

3. Operation and Maintenance: ....$ 3,000.

4. Total Annual Federal Carrying Charge ....$ 29,811.

Construction Period - 1 year

New 2/46

$12,500 – by me – quantity est.
20,000 – chief off.

14. Estimated Cost.- The estimated cost is summarized in the revised definite project report as follows:

Dam Spillway and Outlets	$290,000
Land and Rights of Way	40,000
Relocation	40,000
	$370,000

Since this report was approved, revisions made in the design of the dam and appurtenant structures and the increased costs of construction and materials have resulted in an increased overall cost of the project. The increased cost is summarized as follows:

Construction Cost, including Clearing	$519,000
Reservoir Cost	63,000
	$582,000

Superseded

6 Nov. '45

15. Carrying Charges.- The total annual carrying charge for the reservoir, based upon interest on the investment, on amortization of structures and equipment, and on operation and maintenance, is $27,222, as summarized in the following table.

ANNUAL COSTS AND CARRYING CHARGES

FEDERAL INVESTMENT

1. Total First Cost:

   a. Structures with 50 year life ....$582,000.

2. Interest During Construction:
   (3% for one-half construction period).........$ 8,730.

3. Total Investment:

   a. Structures with 50 year life ....$590,730.
   b. Engineering Expenses .... 42,000.
   c. Total Federal Investment ....$632,730.

ANNUAL FEDERAL CARRYING CHARGES

1. Interest on Investment @ 3%....................$ 18,982.

2. Amortization:
   a. Structures with 50 year life (0.887%).......$ 5,240.

3. Operation and Maintenance: ....$ 3,000.

4. Total Annual Federal Carrying Charge ....$ 27,222.

Construction Period - 1 year.

Superseded

6 Nov, /45